ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXIX. No. 25.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 575

Freight Car Truck Frames..... 576
The Hydraulic Laboratory and Courses of the Massachusetts Institute of Technology (*illustrated*).. 577
An Experience with a Stand-Pipe..... 578
Uniformity in Designs for Special Castings (*with insert*)..... 579
Railway Improvements for the World's Columbian Exposition Traffic—IV..... 579
The San Blas Ship-Canal Project (*illustrated*)..... 580
Tests of the M. C. B. Couplers..... 589
Steel Center Sills for Freight Cars (*illustrated*) . 590
Is the Game Worth the Candle?..... 591
Attachments of M. C. B. Couplers 594
The Value of a Cement Lining in an Irrigation Canal (*illustrated*)..... 593
An Innovation in Valve Gears..... 593
The Louisville & Nashville R. R. Co.'s New Terminal Yards and Station at Nashville, Tenn. (*illustrated*)..... 593
Notes on the Public Works of Boston, Mass., for 1892..... 594

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS..... 582, 595

EDITORIAL NOTES..... 586

Regular Use of the Conductor's Brake Valve as a Train Signal—Another Deep Water Entrance to the Mississippi River—Subsidies by Cities for Public Enterprises.

EDITORIALS:

The Boston Subway Bill..... 586
Breakages of M. C. B. Couplers..... 587

LETTERS TO THE EDITOR..... 588

Large Siphons—Central Peruvian Railway—Fireproof Floor Construction—Concerning the Status of Engineers.

CONSTRUCTION NEWS 597, 600

Railways, Street Railways, Elevated and Cable Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewers, Streets, Electric Light and Power, Contract Prices, Miscellaneous.

INDUSTRIAL NOTES..... 600

Further details of the tunnel under the East and North rivers, noted in our issue of May 25, are given by Mr. Wm. C. Lane, Secretary New York & New Jersey Terminal R. R. Co.

The object sought, he states, is to furnish the city terminal facilities for all trunk line railroads centering in Jersey City. This would make it necessary to build a four-track double tunnel, with air-tight wall between the divisions, from the Hackensack meadows, under Jersey City, Hoboken and the North River to Fourteenth St., New York; thence under Fourteenth St., across the city, with a branch under Hudson St. to Chambers, thence to Wall and Broad Sts. and under Broad to the East River. The length of the tunnel would be six miles, and its cost $16,500,000. The main station is to be near or under Union Square, and the downtown station will be at Wall and Broad Sts. The tunnel will be 125 ft. below the river, cut through the solid rock, and the stations will be not less than 100 ft. below the surface of the streets. A spur, or siding, running under the Postoffice for mail cars and to express offices is projected. Electric motors, furnished by the Edison company, are to be used. Stations will be established in Sixth and Ninth Aves., at Fourteenth, Houston and Chambers Sts.

The company's capital is only $100,000. Its directors are: General H. W. Slocum, Isaac P. Martin, Thomas Rutter, William Marshall, Charles F. Smillie, Isaac D. Fletcher, William S. Jarvis, William S. Lane, Thomas Sturgis, William D. Guthrie and Chas. S. Brown.

The water commissioners of Detroit, Mich., have awarded the contract for crude oil fuel for the ensuing six months to the Sun Oil Co., Toledo, O., at 1.56 cts. per gallon. The Standard Oil Co. bid 1.953 cts. per gallon. Under the old contract 1.61 cts per gallon was paid. It is estimated that $1,056 was saved during the month of May by using oil instead of coal for fuel. Some information regarding the use of oil for fuel at Detroit was given in our issue of March 10, 1892.

The New York Rapid Transit Commission is again on a working basis, the four commissioners who resigned a fortnight ago having withdrawn their resignations and again taken the oath of office. According to the reports, all "differences" have been settled, and the commissioners will work in harmony to give the city rapid transit. This, however, the commission still thinks can only be furnished by the present elevated railway company, for at the first meeting of the reorganized commission it was unanimously decided to again offer the franchise to the Manhattan Elevated Ry. Co. This franchise provides that the company pay the city 5% of its net income, or a lump sum of $175,000 annually, and also pay all expenses of the commission from its beginning. A system of transit devised and built 15 years ago is all the commission can furnish after two years of work and $200,000 of expense.

The battleship "Massachusetts," which was launched at the yards of Wm. Cramp & Sons on June 10, is the second of the three coast line battle ships of our new navy to be launched. She is built of steel and her principal dimensions are: Length over all, 350 ft. 10¼ ins.; length on water line, 348 ft.; extreme breadth, 69 ft. 3 ins.; draft, 24 ft., and displacement, 10,288 tons.

The armor protection consists of a water-line belt of 18-in. armor, which is placed on the hull 3 ft. above and 4½ ft. below the water line. Rising from this belt at each end are armored redoubts 17 ins. thick, extending above the main deck 3½ ft. These redoubts afford an armored freeboard of 15 ft. 2 ins., and protect the turning gear of the turrets and all the loading operations. The turret armor is 17 ins. thick.

The side armor belt is backed by 6 ins. of wood, two ¾-in. plates, and a 10-ft. belt of coal. The vessel above the belt line has 5 ins. of armor protection.

The 8-in. guns have barbettes of 10 ins. and turrets of 8½ ins.

The 6-in. guns are protected by 5 ins. of armor and have 2-in. splinter bulkheads worked around the deck.

The 6-pdr. rapid-fire guns, when mounted between decks, have 2-in. armor worked around them. In other places they have the usual service shield. The 1-pdr. guns are protected by 2 ins. of steel.

The deck over the armor belt is 2¾ ins. thick, and at the ends the under-water decks are 3 ins. thick.

There is a 10-in. armored conning tower, with a 7-in. tube for protecting the void pipes, electric wires, and steering connections.

The battery will consist of four 13 thirty-five caliber breech-loading rifles, four 6-in. breechloading rifles, eight 8-in. breech-loading rifles, 20 6-pdr. and 6 1-pdr. rapid-fire guns, 2 gatlings, and 6 torpedo tubes.

The engines are of the twin-screw, vertical, triple-expansion, inverted-cylinder type; diameter of cylinders being as follows: High pressure, 34.5 ins., intermediate pressure 48 ins., low pressure 75 ins., with a common stroke of 42 ins. There are four double-ended boilers 18 × 15 ft. in diameter, and two single-ended boilers (donkey), 8½ × 10 ft. in diameter. Each boiler and engine is in a separate water-tight compartment, in order to localize possible injury. The normal coal supply is 400 tons, but there is a coal-bunker capacity of 1,800 tons. The contract price was $3,020,000.

The most serious railway accident of the week was the derailment of a train on the Bay Ridge Branch of the Manhattan Beach R. R., near Parkville, N. Y., June 20. The train consisted of an engine, two parlor cars and five open cars of light construction, with steps, or footboards running along the sides, and these cars were crowded with people returning from the races. The road is a double track, but the tracks are gantleted through the tunnel under the Coney Island Boulevard, which is only wide enough for one track. Just outside the tunnel the five open cars left the track, two being pulled partly into the tunnel, and each had one side crushed in against the wall. The other three cars ran against the slope of the cut, and being of light construction, were badly wrecked. There were seven persons killed and nearly 20 injured, most of the casualties being among the people standing or sitting on the long steps. The train was the second section of the regular train, and it is said both trains were running at a high rate of speed.

The new iron bridge over Sugar Creek, near Crawfordsville, Ind., gave way June 15, the piers having been undermined by floods. Both spans went down. The bridge cost $28,000.

Jarrah and karri are two Australian varieties of hard native wood used in Melbourne for street pavement. Mr. George H. Wallace, the U. S. Consul of that city, believes that this wood could be used to advantage in other countries for a similar purpose, and in England a market has already been opened for it, and it has satisfactorily stood the test of 6 years' use in London. It is laid on a 6-in. concrete base; it is very solid, and wears evenly and well, but is somewhat slippery after light showers. Exclusive of concrete base, excavation, laying and grouting, this pavement costs in Melbourne $2.16 for Karri and $2.40 for Jarrah per square yard.

The shrinkage of limestone in burning recently formed the basis of a lawsuit in York, Pa. The authorities state that it does not shrink, but give no method of test. Under these circumstances, Mr. C. H. Ehrenfeld, of York, Pa., tried the following experiments: Several pieces of limestone of varying firmness of texture were permanently marked with two lines and the distance between the lines was carefully measured. The pieces were then burned for seven hours; the distance remeasured, after cooling, and the limestone slacked in water to prove that the burning was complete. Another test was to dip the pieces of stone in melted paraffin until a thin layer was formed, rendering them impervious to water. Their volume was then determined by lowering them into a graduated vessel filled with water. Each piece was then burned; again coated with paraffin after cooling, and again measured in the same way. In both tests no change whatever in volume could be detected.

The Persian government has granted to Mr. Poliakoff, railway contractor, of Moscow, Russia, a 99-years' concession for the construction of a wagon road between Kazvin, Resht and Enzeli, a distance of about 125 miles, with the right of cultivating the land on both sides of the road, and permission to levy tolls. He will also have the refusal of a concession for the construction of a railway between Kazvin and Enzeli, and is to be indemnified should other parties execute such a work. The cost of construction is estimated at $500,000. The Belgian company's railway and street railway lines between Teheran and its suburbs are now in the hands of the Russians, who are extending the railway and operating the street railway.

Good progress is reported on the driven well plant for the new water supply of Lowell, Mass., under the direction of Mr. L. D. May, of the Cook Well Co. About 20 wells have been sunk thus far, and in addition experiments are being made with an oblique or horizontal tube well, similar to several sunk by the same company in the West and described in Engineering News of May 11, 1893. The present water supply of Lowell is from the much polluted Merrimac River. Lawrence draws its supply from the same source and is now putting in filter beds to purify the river water. It will be interesting to see which city secures the best results from its new supply.

The method adopted by the Brooklyn (N. Y.) Elevated Ry. in reducing the grade of its Myrtle Ave. line between North Portland Ave. and Adelphi St. without stopping traffic is worthy of mention. The Washington Park slope has been one of the most difficult grades in the city to overcome, and the delay and danger caused by slipping rails in wet weather led the company to undertake the work. The tracks are to be lowered 5 ft. 8 ins. at Cumberland St., which is the top of the hill, and the lowering begins at North Portland Ave., and ends at Adelphi St. The structure is supported by large timbers, which are bolted to the side columns and wedged up until the whole weight of the girders rests on them. Then iron bars are bolted to the girders to prevent lateral motion, and the columns are shortened the required amount. Hydraulic jacks, capable of supporting 60 tons, are then used to support the structure, while the wedges are loosened, and the supporting blocks withdrawn, and the track is slowly lowered into its place. This work is carried on on both sides of the avenue at the same time, and so carefully and securely is the enormous weight handled that there has been no interruption to the regular traffic of the road.

A new conduit system of electric traction, was recently tested on a short experimental track at Coney Island with very good success, it is stated. As near as can be determined from the newspaper reports the system consists of a conduit provided with so-called contact boxes at short intervals. In the contact boxes the cable is bare, but elsewhere it is covered with lead pipe insulation. Up to the bottom of the cable the contact box is filled with solid paraffine, and the remainder of the box is filled with high-grade paraffine oil. At the top of the box projects an arm fastened to a rod, at the lower end of which is a copper brush for making a contact with the cable pieces. The position of the contact arm is so controlled by a stout spring that when no car is passing the brush is in its normal position and no current is passing either to the ground or the rail or in any way involving leakage or endangering life. The peculiarity of the arm is that it is constructed on the plan of the telescope, so that a car may back and get the current without any strain being brought on the box or the cable. The shoe by which the current is taken into the car, instead of being a short device, similar to the cable grip, is made nearly the length of the car, being 9 ft. and 2 ins. long. It is constructed flexibly, in such a manner as to enable the car to take any curve, however sharp, and still preserve absolute contact with the boxes.

A ship canal, to cost $400,000, has been authorized by the town council of Bruges, Belgium, to connect that city with the sea. Bruges thus hopes to restore her old time commercial importance and to again take rank with Antwerp, Ghent and other cities in the Low Countries now having similar artificial waterways.

FREIGHT CAR TRUCK FRAMES.

A report on this subject was presented at the convention of the Master Car Builders' Association last week by Messrs. J. C. Barber (No. Pac.), W. S. Morris (Ches. & Ohio), and S. A. Crone (N. Y. C. & H. R.). The committee sent a circular letter containing 50 questions to the members of the Association and received 53 replies. The following is a summary of the information collected:

Rigid and Swing Bolster Trucks.—Answers received covering 377,614 cars in service showed that about as many swing trucks as rigid trucks are now in use. There is a decided tendency, however, to substitute the rigid truck for the swing pattern. For example, 30 members have adopted the rigid truck as a standard on heavy cars and 7 members have adopted the rigid truck. Others propose soon to change from the swing to the rigid, and while there are still numerous advocates of the swing truck the majority is strongly the other way. A swing truck costs 2% to 30% more to build than a rigid truck, and 1% to 30% more for repairs. On the other hand, it is to be remembered that these figures refer mostly to old patterns of swing trucks. It is possible that the swing trucks of modern design which many companies are experimenting with, may prove better able to compete with the rigid trucks.

There is a difference of opinion as to the relative safety of the two trucks: 23 members reported that a swing truck was practically no safer than a rigid truck, while 11 considered it safer, and two confessed themselves undecided. In passenger car service a swing truck is generally believed to be desirable for easy riding, and 32 members favored it for this reason; 2, however, did not think it necessary and 5 thought it necessary only because of the long distance between truck centers. The committee commented that if the swing motion is necessary for easy riding in passenger cars, it is a good point in its favor for freight service.

As respects relative wear and heating of journals, 32 reported that they knew no difference between the two trucks in this respect; but 3 thought the rigid truck had fewer hot boxes, and 3 were equally confident that similar credit was due to the swing truck. A somewhat similar showing was made concerning relative breakage of bolster springs, 22 members reporting the swing truck to be no more severe on them than the rigid, 9 condemning the swing truck in this respect and 8 reporting undecided. Wear and breakage of wheel treads and flanges appear to be substantially the same, 27 reporting no difference and only 4 reporting a difference in favor of the swing truck. The final question was whether a swing motion truck would be preferred if it cost no more to build and maintain than the rigid and were considered superior in wear on track and truck and in easy riding. Naturally 90% of the members replied yes to this question, but 7 still adhered to the rigid truck. As respects lateral motion of the swing bolster, the committee recommended 1 in. allowance each way as ample.

Truck Check Chains.—Out of 40 members, 14 considered truck check chains desirable for safety in derailments, and 26 believed them to be of no value whatever. The majority of replies indicated that they did more damage than good. They are not strong enough to prevent the truck from twisting into all sorts of positions when derailment occurs; but they are strong enough to split the sills and twist the truck frames at such times. Their cost is about $4.50 per car and about 55 cts. per year for maintenance. It is questionable whether they should not be done away with altogether.

Center Plates.—Thirteen members favor pressed steel, 9 malleable iron, 8 cast iron, and 9 are undecided.

General Dimensions.—In four-wheel freight trucks 6 ft. 3 ins. between truck spring centers, the side bearings are placed 5 ft. c. to c. by 16 members and from 4 ft. to 4 ft. 10 ins. by 23 members. Truck spring centers are placed 6 ft. 3 ins. apart by 23 members and 16 place them 5 ft. to 5 ft. 10 ins. The committee recommended that to get the greatest capacity at least expense the springs should rest as nearly as possible over the center of the frames and journals. An inspection of 63 freight cars, belonging to different roads, in actual service, showed that the trucks with springs located over the frames were in much better condition than where the springs were located away from the frames.

Truck Bolsters.—Twenty-eight members out of 38 reported difficulty with truck bolsters springing down at the center, requiring the center plate to be frequently blocked up to allow free motion between side bearings; 33 members reported that this trouble occurred with trussed wooden bolsters and 6 reported that such bolsters gave no trouble. In double-trussed bolsters, common practice seems to be to rest the ends of truss rods on a shoulder inside the truss frame, 24 members reporting this practice; 9 rest truss rods on the end of bolster outside the truck frame and 3 do not truss bolsters.

The depth of the saddle over which the truss rods pass at the center varies from 1 to 4½ ins. The compound bolster, composed of two or more iron or steel plates applied edgewise and bolted together between timbers was reported to be giving trouble through shrinkage of the timber on 7 roads and to be giving no trouble on 11 roads. The committee made several tests of the deflection and permanent set of bolsters, which showed in general that the wooden bolsters even when trussed were not as stiff as the compound bolsters. Out of 37 members 15 are using plain oak bolsters not trussed, of sizes varying from 10 × 12 ins. to 9½ × 10½, and 22 use trussed bolsters. All the members reporting, however, were in favor of increasing the strength and stiffness of truck bolsters.

Metal Channel-Bar Transoms.—Twenty-six members do not use channel-bar transoms of iron or steel. Of those who do, nearly all use the M. C. B. standard channel; the lengths vary from 6 ft. 6 ins. to 7 ft. 5 ins. Nine members rivet channel-bars to truck columns, and 5 bolt them flatwise to the truck columns.

No. of Parts.—The number of parts in swing beam trucks varies, according to the answers received, from 145 to 466. The rigid truck varies from 85 to 145. In many of the trucks of recent design the number of parts has been decreased nearly 20%.

Wood vs. Metal.—Twenty-five members reported that trucks with wooden transoms and bolsters were expensive to maintain on account of the wood shrinking and warping; 11 reported no trouble on this score. The committee inspected 61 different styles of freight trucks and found wooden transoms and bolsters in every case more or less defective owing to the shrinking, checking, warping and splintering of parts. Timber not thoroughly seasoned is unfit for car construction; and as car builders cannot obtain seasoned timber, steel or wrought iron should take the place of wood; 29 members stated that a metal truck was cheaper to maintain than a wooden one; 10 were of a contrary opinion. The committee believed that a good metal truck could be maintained for 18% less than the best wooden truck; and its first cost is only 5 to 15% more than that of a common wood and cast iron truck.

Wheel Base.—The majority favored 5 ft.; but a number prefer to increase this from 2 to 6 ins.

Arch Bars.—The present status is:

Members.	Top bar.	Bottom bar.	Tie strap.
23.....	1¼ × 4 ins.	1⅛ × 4 ins.	¾ × 4 ins.
8.....	1⅛ × 4 ins.	1 × 4 ins.	¾ × 4 ins.
(A few).....	1⅜ × 4 ins.	1 × 4 ins.	¾ × 4 ins.

All these dimensions were reported as being entirely satisfactory. For column bolts, 29 use 1¼-in.; 5, 1⅜-in. and 4, 1½-in. For securing column and oilbox bolts the majority use one nut with spring cotter; but 29 members reported difficulty in getting the cotter to lock the nut closely on account of the varied distance caused by shrinkage of the casting. Many members are experimenting with patent nutlocks.

Brake Gear.—Twenty-six favor suspending brakes from the truck and 14 prefer to suspend from the car body. Many members say that inside hung brakes suspended from the truck transoms are cheaper in first cost and cost of maintenance and aid in preventing brakeshoes from wearing the wheel flanges, due to the swaying of the car body. Twenty-seven members consider metal brake-beams more economical than double-trussed wood beams, while 11 considered a wood beam more economical. The committee satisfied itself that the metal beam was as cheap in first cost and 3% to 7% cheaper to maintain than the wood beam.

Fox Pressed Steel Truck.—Eleven members who have tried this truck favor it, and 2 do not.; 22 consider it objectionable on account of not admitting so low a car body as the diamond truck; 14 had no objections on this score; 21 thought the truck springs would not give as good service when placed, as in this truck, on top of the oilboxes, and 15 thought the truck springs would be quite as serviceable; 26 did not think the space provided in this truck for coil springs was large enough for cars of 60,000 lbs. capacity; 13 thought the space large enough; 14 objected to the riveting together of the transoms and the side arches, but 25 held this to be no fault in the truck. The pedestal jaw of the pressed steel truck was held to make it more difficult to remove or replace wheels than on the diamond truck by 29 members, but 9 anticipated no difficulty in this respect and 2 said that if wheels were taken out in a modern drop pit the cost would be reduced. Of other points for and against the truck, the saving of 1,500 lbs. weight per car and the reduction in cost of repairs are in its favor. The difficulty in inspecting wheels on account of the pedestal broadly covering the wheel face, and the difficulty of repairs when badly bent in a wreck, are against it. There was a nearly unanimous opinion that if the pressed steel truck proves a permanent improvement in freight service a pressed steel truck with swing motion and elliptic springs should be designed for use under passenger cars.

M. C. B. Standards.—Eighteen members reported the M. C. B. journal-box, lid and key to be satisfactory, and 21 found them unsatisfactory.

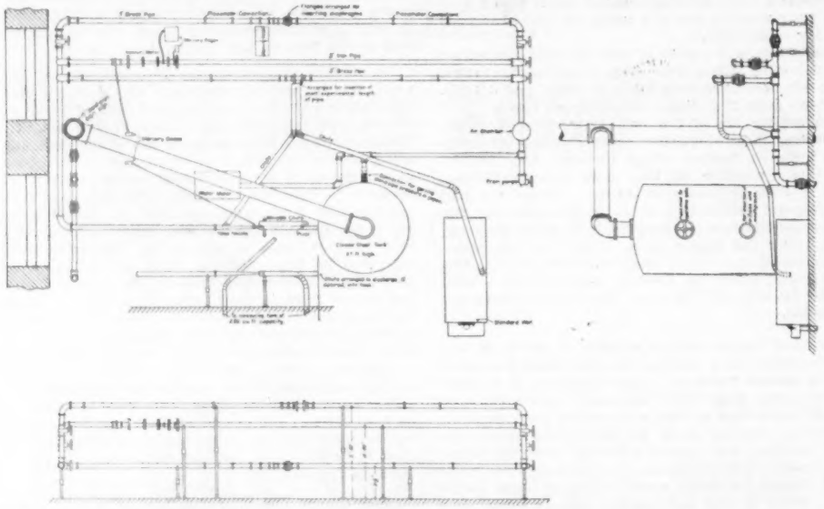


FIG. 1. GENERAL ARRANGEMENT OF PIPE AND APPARATUS ON THE SECOND FLOOR OF THE HYDRAULIC LABORATORY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

In conclusion, the committee thought the possibility of a standard design of freight truck being adopted was very remote. The trucks of modern design of wrought iron and steel are, however, far superior to the old fashioned truck built of wood and brittle cast iron, and most new equipment is fitted with them. The following are the points in which improvement is easiest and most desirable:

1. Uniformity in dimensions of materials used in arch and tiebars, transom and bolster truss rods, oil box and column bolts, side bearing and center plate bolts, spring steel used in elliptic springs, iron and steel truck transoms.
2. Truck bolsters made and designed with a sufficient factor of safety to carry the marked capacity of the car without deflection enough to disturb free action of the side bearings.
3. Many of the trucks need to be redesigned with a view of diminishing the number of parts fully 25%, thereby reducing first cost and maintenance.

THE HYDRAULIC LABORATORY AND COURSES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Many centuries ago a king, more fond of study than kings in those days were apt to be, found the tasks assigned to him by his philosopher teacher more difficult than he enjoyed. The answer given by the sage to his pupil's inquiry for an easier method has become a proverb. It is true now as then that "there is no royal road to knowledge"; but on the other hand, in view of the wonderful aids with which the acquirement of knowledge at the present time is surrounded, one may well believe that could that ancient pupil and teacher view the progress of the present day, the latter would be willing to relinquish to his royal master the title of sage.

Engineers who recall time spent in their student days over pages of textbooks which seemed to contain meaningless abstractions, must view with envy the lot of students of the present day who are taught how to apply their knowledge as they receive it, and are aided at every step to a correct and clear understanding of the subject before them by every means which ingenuity can devise.

An excellent example of the most modern methods of instruction in engineering schools is the hydraulic laboratory of the Massachusetts Institute of Technology, which was described at the meeting of the New England Water-Works Association this week in a paper by Prof. Dwight Porter, illustrated by the stereopticon. We are indebted to Professor Porter for the following description of the methods and apparatus employed in studying hydraulics at the Institute and for drawings and photographs showing the interior of the laboratory and the students at work with the apparatus.*

Instruction in hydraulics is given in the fourth or senior, year, as follows:

Hydraulic Laboratory.—The laboratory has been arranged and equipped upon an extensive scale for experimental researches and practical tests in hydraulics. The apparatus is used by the students of nearly all the engineering courses in regular laboratory exercises, during which they work in sections no larger than are strictly necessary for conducting the particular experiment in hand. Such work is designed to give the students a practical demonstration of laws with which they have become familiar in a theorectical way only, to acquaint them with the appearance and behavior of certain standard forms of apparatus, and to teach them the methods and precautions commonly necessary in hydraulic experiments. The time allotted to any one variety of work is what seems sufficient fairly to attain the above ends and no more, it not being proposed in class exercises to make the young men adepts, nor in general to achieve results of especial scientific importance. In connection with thesis work, or the studies of post-graduate students, special apparatus is every year devised and installed, suited to original investigations and to the securing of results of permanent interest and value.

The space devoted to the hydraulic laboratory covers about 30×50 ft. on each of the two lower floors of the engineering building. The general arrangement of pipe and apparatus on the second floor of the laboratory is shown by the plan, Fig. 1, and the view, Fig. 2. The primary source of water supply is the city main, but it is rarely that draft is made directly upon this during an experiment, water being supplied from pumps, which in turn draw from a large receiving pit sunk below the basement floor, the discharge from all experiments finding its way to the pit and thus being used over and over. Several pumps are in use, steam, rotary and centrifugal, supplying the different apparatus. In order to secure a more constant pressure than that from the pumps, for certain kinds of experiments, a 10-in. stand-pipe, shown in plan in Fig. 1, 80 ft. high, has been built, reaching to the top of the building. The supply to this from the pumps may be so regulated by valves and overflows, conveniently arranged on each floor, that the head shall be kept at any desired point during an experiment, with a fluctuation of scarcely 1-100 ft. Many of the pieces of apparatus have been so arranged that they can be run at will under pressure either from the stand-pipe or directly from the pumps.

An important feature of the plant is a closed steel tank, 5 ft. in diameter and 27 ft. high (Figs. 1, 2 and 4), extending from the basement floor upward through two stories. It is connected at top and at bottom with the 10-in. stand-pipe, and at four points on each floor is arranged for the insertion of orifices, free or submerged, mouth-pieces and other

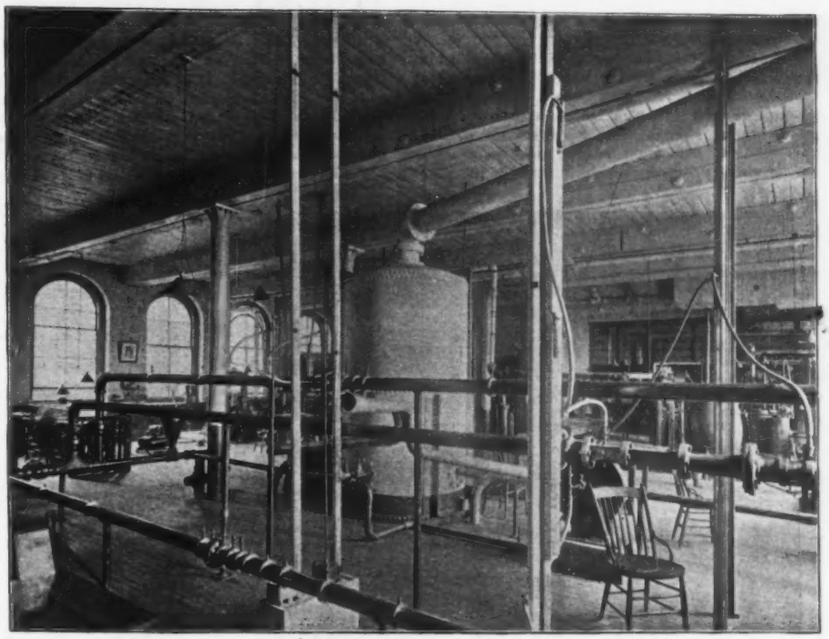


FIG. 2. VIEW OF SECOND FLOOR OF HYDRAULIC LABORATORY.

fittings, and for connections with motors and experimental pipes. It is fitted with hydraulic gates so planned that an orifice, for example, may be quickly exchanged for another, without the necessity of drawing down the water in the tank.

For certain experiments on the flow of water through pipes, three lines of 3-in. pipe (Figs. 1 and 2) have been erected. One of these is of iron, with a Venturi meter, shown on the right of the foreground of Fig. 2, inserted in its course; the other two are of brass, very carefully made, with piezometer connections of approved form at sundry points. One of the brass pipes is arranged for the insertion of diaphragms with orifices of

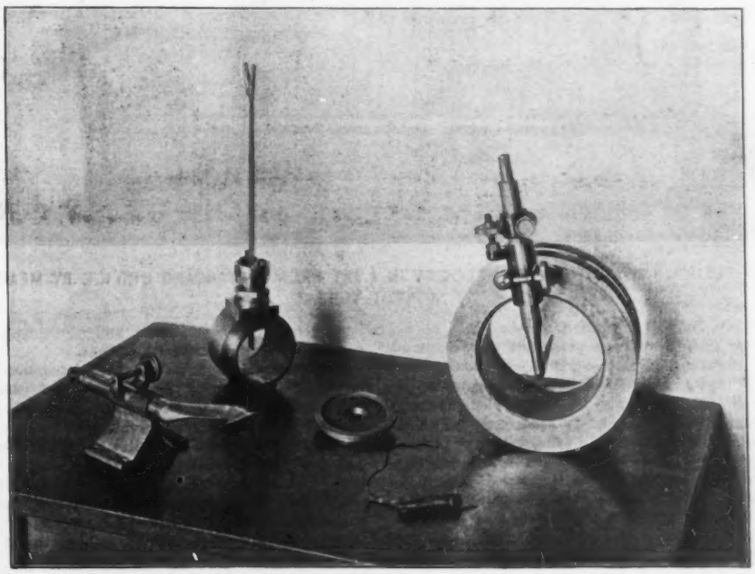


FIG. 3. FORMS OF PITOT TUBES USED IN EXPERIMENTS ON THE VELOCITIES IN FLOWING WATER.

*A historical review of the Institute, and an account of its high rank among technical shools, were given in our series of articles on "The Engineering Schools of the United States," June 9 and 30, 1892. Professor Porter's paper before the New England Water-Works Association will be published in the Journal of that body. It included only that part of the present article which relates to the hydraulic laboratory and fieldwork of the Institute, but was illustrated by a large number of views.

various sizes; and the other, for the insertion of short experimental pieces of pipe provided with side orifices, branches, or other devices. The discharge from the various pipe lines passes finally through a hose nozzle, with pressure-gage connection to be used in determining the coefficient of discharge. The nozzle discharges (Fig. 1) into a movable double chute, through one branch of which the flow may be wasted until it is desired to begin an experiment, when the other branch may instantly be thrown into the path of the jet, and the water directed through the floor into a measuring tank beneath.

For delicate observations upon the velocity at any given point in flowing water, the laboratory contains three different instruments, embodying the principle of the Pitot tube. Different forms of these are shown by Fig. 3. Two of these, for use, respectively, in jets from nozzles and in streams flowing under pressure through pipes, are the property of Mr. John R. Freeman, M. Am. Soc. C. E., by whom they have been placed at the command of the Institute. The third, for jets from standard orifices, has been designed especially to use on the large tank which has been described, and one in use is shown by Fig. 4. In each case, the pressure of the flowing water due to its velocity is transmitted through a minute orifice and a connecting tube to a mercury gage, the reading of which indicates the velocity at the tip of the tube. A simple attachment to the last mentioned of these devices has permitted measuring the shape of the jet and the size of the contracted vein with the greatest nicety.

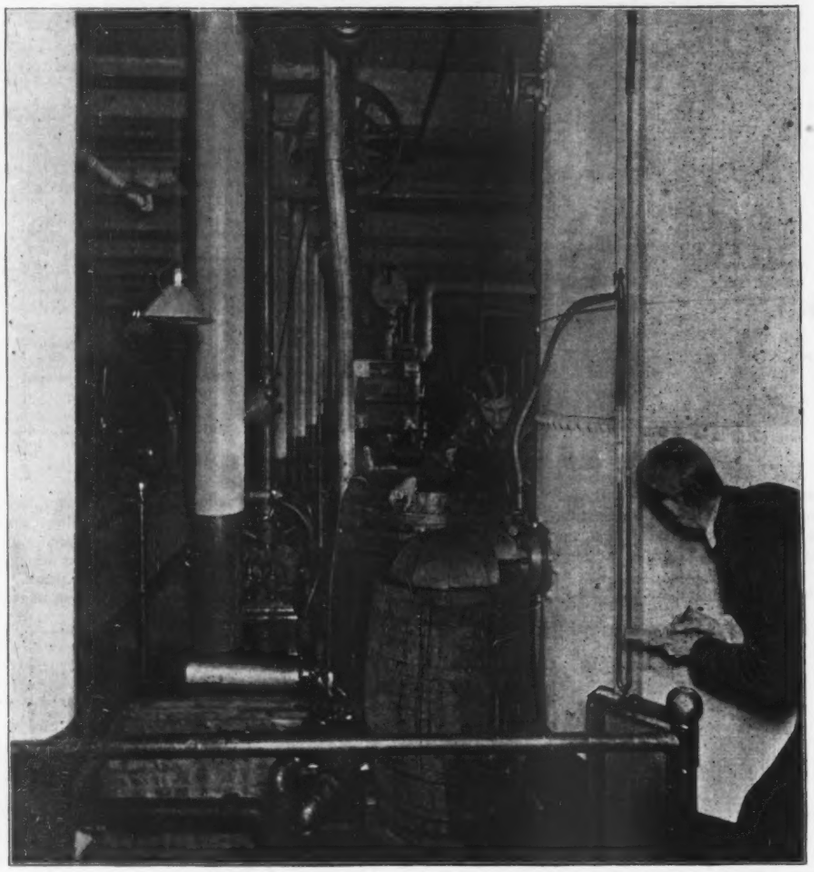


FIG. 4. STUDYING VARIATIONS OF VELOCITY IN A JET FROM A STANDARD ORIFICE BY MEANS OF A PITOT TUBE.

For measuring the quantity of water discharged during experiments, the common method employed is that of weighing, the temperature of the water being at the same time observed. Thus, in determining the coefficient of discharge of standard orifices, the flow from the orifice passes into a large cask, with ample discharge pipe and quick-acting valve at the bottom, and thence into another and similar cask underneath, resting directly upon scales. The upper cask serves for temporary storage while the contents of the lower one are being weighed and discharged. By this means, with casks of moderate size, it is not difficult to weigh continuously at the rate of 40,000 or 50,000 lbs. of water per hour. Again, the discharge from experiments on the second floor may be diverted through chutes to any one of several measuring devices on the floor below. One of the most important of these is a cylindrical steel tank 6 ft. in diameter and 10 ft. high, capable of holding some 280 cu. ft. of water. This tank is conveniently placed for drawing off and weighing the contents, and is by this means calibrated. In order to determine the quantity discharged into the tank in any experiment, it is then necessary only to read a glass gage attached to the tank and provided with sliding sight and vernier. For more indirect determinations of quantities of water, the laboratory contains a number of weirs of different lengths, up to 4 ft., a calibrated orifice tank, Venturi and other water meters, nozzles and standard orifices.

The pieces of apparatus which have been mentioned will suggest to the mind a great variety of experimental work to which they are suited, and to much of which they have actually been applied. The laboratory further contains a Pelton water motor, a small Swain turbine, a Douglas hydraulic ram and a variety of dynamometers, mercury gages, piezometer fittings, etc. Fig. 5 is a view of a Swain turbine being tested by students. There have also been placed in the laboratory a large number of finely constructed orifices and metal pieces of sundry descriptions, which were used many years ago by Uriah Boyden and James B. Francis in their famous experimental work at Lowell.

The laboratory has been designed with a view to extensive further developments, important advances in which are likely to be made every year. It has been steadily taxed to its utmost capacity, both for regular class exercises and for thesis work, and fully commends itself as a substantial aid in engineering education.

Hydraulic Motors.—The study of hydraulic motors is taken by students in mechanical engineering, and includes the theory of the flow of water over curved vanes, the principles governing the speed, losses of energy and efficiency of turbines, methods of regulation and the design of impulse and reaction wheels. In the hydraulic laboratory, tests are made by the students upon both these forms of motors, and in the class room a 15-in. turbine of the most approved construction is used for illustration and study. Bodmer's "Hydraulic Motors" is at present used as a text-book, and the study is accompanied by the assignment for solution of various problems of a practical nature.

Field Work.—The course in field work is taken by civil engineering students of the hydraulic and geodetic options. It consists in measuring the flow of some stream by means of current meters and floats. The department is equipped with Fteley, Ellis, and Ritchie-Haskell current- meters, and with tubes, Ellis sub-surface and other forms of floats. Measurements have been made, at various times, of the flow of the Charles, Merrimac, Connecticut and Schoharie rivers, and of the hydraulic canals at Lowell and Lawrence. These streams have given a range in volume from 50 to 8,000 or 10,000 cu. ft. per sec., and a great variety of conditions as regards width, depth, velocity of current, and methods of conducting the measurements. The observations made in the field are worked up in the drafting room in the form of computations, diagrams being constructed for the cross sections and velocity curves.

Theoretical Hydraulics.—This subject is taught by the aid of a text-book, "Notes on Hydraulics," by Prof. George F. Swain, with class-room quizzes. The topics studied include hydrostatics, and the flow of water through orifices, mouth-pieces, pipes, open channels, and over weirs.

Hydraulic and Sanitary Engineering.—Instruction in these branches is given partly by the use of text-books (Baumeister's "Cleaning and Sewerage of Cities," and Gerhard's "House Drainage"), and partly by lectures.

Sewerage, drainage, and water supply, hydrology, irrigation and water power are taken up, and it is sometimes practicable to give a short course also upon river and harbor works. Important works for water supply, sewerage and sewage disposal, and extensive parks are under construction in or near Boston, affording rare facilities for studying the most advanced practice in such matters.

A series of lectures is also given each year to the students by eminent practicing engineers. Thus, for example, during the spring of 1893 there were lectures by Col. Charles W. Folsom on sewer inspection, by Mr. Desmond FitzGerald, M. Am. Soc. C. E., on the water supply system of Boston, and by Mr. John R. Freeman, M. Am. Soc. C. E., on the hydraulics of fire protection.

Hydraulic and Sanitary Design.—In this section various problems are assigned in connection with sewerage and water supply. For a problem in sewerage design, a lithographed map of Everett, one of the suburbs of Boston, has been prepared, with elevations and contours complete. The student having previously become familiar with all operations involved in surveys and drawings for such a map, no time is lost in proceeding to the actual design. To each student is given a single subdivision of the town, for which he arranges a main line and perhaps one or two branch lines of sewer, constructing profiles, and, with reasonable assumptions, fixing the grades and determining the proper sizes of the sewers.

AN EXPERIENCE WITH A STAND-PIPE.*

By John C. Chase, M. Am. Soc. C. E.

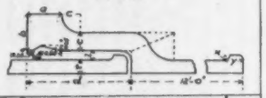
The water-works which the writer has in charge (Wilmington, N. C.) was constructed some twelve years ago. Two local capitalists were interested in the scheme by an outside party, whose chief end was, apparently, to secure the contract for constructing the works.

The works were built without any engineering advice, so far as the owners of the system were concerned, except that furnished by the interested contractor.

One feature of the system was a 20 × 70-ft. plate

*Abstract of a paper read at the annual meeting of the American Water-Works Association, at Worcester, Mass., June 15, 1893. The full paper, with discussion, will be published in the Journal of the Association.

1 PIPES.

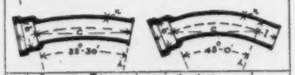


Diam. of Pipe.	Class.	Dimensions in Inches. a	b	c	d	t	l	x	y	Weight.
3	B	1.80	1.20	Effect	4.70	0.40	0.40	0.20	0.00	180
4	B	1.80	1.30	0.65	4.0	0.42	0.40	0.20	0.00	200
6	B	1.80	1.40	0.74	4.0	0.80	0.40	0.20	0.00	420
8	B	1.80	1.50	0.76	4.0	0.55	0.40	0.20	0.00	600
10	B	1.80	1.60	0.84	4.5	0.59	0.40	0.20	0.00	815
12	A	1.80	1.60	0.80	4.5	0.58	0.40	0.20	0.00	935
12	B	1.80	1.70	0.88	4.5	0.65	0.40	0.20	0.00	1070
14	A	1.78	1.70	0.85	5.0	0.66	0.50	0.20	0.01	1415
14	B	1.78	1.90	0.95	5.0	0.75	0.50	0.20	0.01	1615
16	A	1.78	1.90	0.95	5.0	0.73	0.50	0.20	0.01	1870
20	B	1.78	1.90	0.95	5.0	0.81	0.50	0.20	0.01	2370
24	A	2.00	2.10	1.05	5.0	0.91	0.50	0.20	0.01	2890
24	B	2.00	2.10	1.05	5.0	0.94	0.50	0.20	0.01	3285
30	A	2.00	2.30	1.15	5.0	0.93	0.50	0.20	0.01	3690
30	B	2.00	2.30	1.15	5.0	1.10	0.50	0.20	0.01	4235
36	A	2.00	2.50	1.25	5.0	1.04	0.50	0.20	0.01	4930
36	B	2.00	2.50	1.25	5.0	1.25	0.50	0.20	0.01	5800
42	A	2.00	2.70	1.35	5.0	1.12	0.50	0.20	0.01	5800
42	B	2.00	2.70	1.35	5.0	1.35	0.50	0.20	0.01	7190
48		2.00	2.70	1.35	4.0	1.00	0.50	0.20	0.01	6375
48	A	2.00	3.00	1.50	5.0	1.55	0.50	0.20	0.01	7980
60		0.25	3.00	1.70	6.0	1.375	0.50	0.20	0.01	10960

2 ONE QUARTER CURVES.

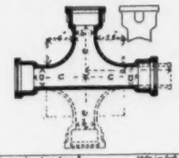
Diam. of Pipe.	Class.	Dimensions in Inches. b	t	r	c	l	Weight.
3	B	4.6	0.40	16	22.6	8	55
4	B	5.8	0.45	16	22.6	8	80
6	B	7.8	0.50	16	22.6	8	125
6	B	7.8	0.50	24	34.0	6	150
8	B	9.9	0.55	16	22.6	10	185
8	B	9.9	0.55	24	34.0	6	215
10	B	12.0	0.60	24	34.0	6	295
10	B	12.0	0.60	24	34.0	C	295
12	B	14.1	0.65	16	22.6	12	330
12	B	14.1	0.65	24	34.0	6	375
16	B	18.5	0.75	24	34.0	12	645
20	B	23.2	0.85	24	34.0	12	880
24	B	28.3	0.96	30	42.4	12	1355

3 1/16 CURVES. 1/8 CURVES.



Diam. of Pipe.	Class.	Dimensions in Inches. b	t	1/16 Curves. r	c	Weight.	1/8 Curves. r	c	l	Weight.
3	B	4.6	0.40	48	18.7	90	24	18.4	4	95
4	B	5.8	0.45	48	18.7	95	24	18.4	4	95
6	B	7.8	0.50	48	18.7	85	24	18.4	4	95
8	B	9.9	0.55	48	18.7	120	24	18.4	4	135
10	B	12.0	0.60	48	18.7	165	24	18.4	4	185
10	B	12.0	0.60	120	46.8	310	60	46.9	—	310
12	B	14.1	0.65	48	18.7	210	24	18.4	4	235
12	B	14.1	0.65	120	46.8	400	60	46.9	—	400
16	B	18.5	0.75	120	46.8	620	60	46.9	—	620
20	B	23.7	0.85	120	46.8	845	60	46.9	—	845
24	B	28.9	0.96	120	46.8	1125	60	46.9	—	1125
30	A	33.2	0.93	120	46.9	1400	60	46.9	—	1405
30	B	33.2	1.10	120	46.8	1620	60	46.9	—	1620
36	A	38.1	1.04	180	70.3	2615	90	68.9	—	2615
40	A	43.25	1.13	180	70.3	3120	90	68.9	—	3130
48	A	51.5	1.25	180	70.3	4215	90	68.9	—	4215

4 BRANCHES.



Dimensions in Inches. a	b	c	d	e	Weight. Three Way Branches Two Bells	Three Bells	Four Way Branches Three Bells	Four Bells
4	3	10.5	23.5	11				
4	4	11.0	23.5	11		185		
6	3	10.5	23.5	12		160		
6	4	11.0	23.5	12		165		
6	6	12.0	24.0	12		205		
8	3	10.5	23.5	13		200		
8	4	11.0	23.5	13		220		
8	6	12.0	24.0	13		250		
8	8	13.0	25.0	13		290		
10	4	11.0	23.5	14		290		
10	6	12.0	24.0	14		325		
10	8	13.0	25.0	14		360		

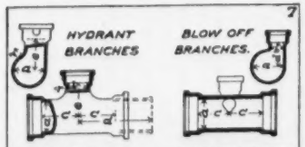
5 BRANCHES.

Dimensions in Inches. a	b	c	d	e	Weight. Three Way Branches Two Bells	Three Bells	Four Way Branches Three Bells	Four Bells
10	10	19	26	15	400	420		
12	6	17	25	15	360	380		
12	8	17	25	15	380	400		
12	8	13	25	15	420	440		
12	10	19	26	15	420	440		
12	12	19	27	15	440	460		
14	8	17	25	17	580	580		
14	10	17	26	17	580	580		
14	12	17	27	17	620	620		
14	14	17	28	17	620	620		
16	6	18	26	17				
16	8	13	25	17				
16	10	19	26	17				
16	12	19	27	17				
16	14	19	28	17				
16	16	19	29	17				
20	6	18	26	19				
20	8	13	25	19				
20	10	19	26	19				
20	12	19	27	19				
20	14	19	28	19				
20	16	19	29	19				
20	20	19	31	19				
24	6	18	26	21				
24	8	13	25	21				
24	10	19	26	21				
24	12	19	27	21				
24	20	19	31	21				
24	24	21	33	21				
30	12	19	27	24				
30	16	17	29	24				
30	20	19	32	24				
30	24	21	34	24				
30	30	24	36	24				
36	12	19	27	27				
36	16	17	29	27				
36	20	19	32	27				
36	24	21	34	27				
36	30	24	36	27				
36	36	27	39	27				

6 BRANCHES.

Dimensions in Inches. a	b	c	d	e	Weight. Three Way Branches Two Bells	Three Bells	Four Way Branches Three Bells	Four Bells
36	16	17	29	27				
36	20	19	30	27				
36	24	21	36	27				
36	30	24	41	27				
36	36	27	46	27				
40	12	18	27	29				
40	16	17	29	29				
40	20	19	30	29				
40	24	21	36	29				
40	30	24	41	29				
40	36	27	46	29				
40	40	29	46	29				
48	16	17	29	33				
48	20	19	34	33				
48	24	21	36	33				
48	30	24	41	33				
48	36	27	44	33				
48	40	29	46	33				
48	48	33	50	33				

7 HYDRANT BRANCHES. BLOW OFF BRANCHES.



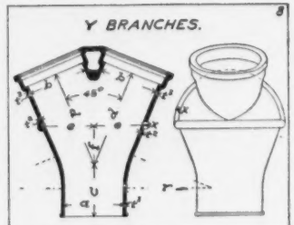
HYDRANT BRANCHES.

DIMENSIONS IN INCHES. a	b	c	d	e	f	Weight.
10	6	12	24	11	5	
12	6	12	24	12	5	
16	6	12	24	15	5	

BLOW OFF BRANCHES.

DIMENSIONS IN INS. a	b	c	d	Weight.
6	4	10	7	
10	4	10	8	
12	4	10	10	
16	4	10	12	
20	6	12	14	
24	6	12	16	
30	12	13	20.5	
36	12	13	23.5	
40	12	13	26.5	
48	16	24	29.5	

8 Y BRANCHES.



DIMENSIONS IN INCHES. a	b	c	d	e	f	r	t¹	t²	t³	X	Weight.
20	20	18	34	17.6	13.2	24	0.85	1.10	0.85	1.25	
24	24	18	38	20.6	13.2	30	0.94	1.20	0.94	1.25	
30	24	18	38	20.6	15.05	30	1.10	1.20	0.94	1.25	
30	30	18	48	25.3	19.0	30	1.10	1.40	1.10	1.25	
36	36	18	54	29.8	21.0	24	1.09	1.50	1.09	1.50	
40	40	18	60	33.2	24.0	24	1.12	1.60	1.12	1.50	
48	48	18	68.5	39.5	28.0	24	1.25	1.75	1.25	1.50	

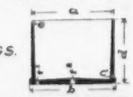
9 OFFSETS.

Diam. of Pipe.	Dimensions in Inches. a	b	c	l	r	t	Weight.
4	2	5.8	13.84	10	8	0.45	90
6	2	7.8	13.84	10	8	0.50	140
6	2	7.8	26.25	10	16	0.50	170
8	2	9.9	17.38	10	10	0.55	215
8	2	9.9	28.38	10	15	0.55	255
10	2	12.0	24.78	10	12	0.60	310
10	2	12.0	—	10	—	0.60	—
12	2	14.1	29.25	10	14	0.65	430
12	2	14.1	—	10	—	0.65	—

10 SIPHON PIPES.

Diam. of Pipe.	DIMENSIONS IN INCHES. a	b	c	d	r	y	t	l	Weight.
4	2	8	8	24.25	16	16	0.45	66.5	150
6	2	8	8	27.70	16	16	0.50	73.0	260
8	2	8	8	30.00	18	16	0.55	78.0	400
10	2	8	8	31.10	18	16	0.60	80.2	580
12	2	8	8	33.25	20	16	0.65	82.5	740

PLUGS.



Diam. of Pipe.	DIMENSIONS IN INCHES. a	b	c	d	e	t¹	t²	Weight.
3	3.8	4.00	0.85	5.5	0.156	0.35	0.35	15
4	4.9	5.00	0.85	5.5	0.156	0.35	0.35	6
6	7.0	7.00	0.85	5.5	0.156	0.35	0.35	10
8	9.00	9.00	0.85	5.5	0.156	0.35	0.35	12
10	11.00	11.00	0.90	6.0	0.20	0.40	0.40	18
12	13.00	13.00	0.90	6.0	0.20	0.40	0.40	28

11 SLEEVES.

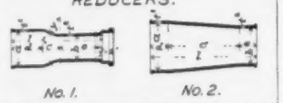
Diam. of Pipe.	DIMENSIONS IN INCHES. a	b	d	l	t	Weight.
3	1.8	1.2	4.6	10	0.6	35
4	1.8	1.3	6.8	10	0.65	45
6	1.8	1.4	8.8	10	0.7	67
8	1.8	1.5	10.1	12	0.75	100
10	1.8	1.6	12.26	12	0.8	130
12	1.8	1.7	14.26	14	0.85	185
14	1.78	1.8	16.76	15	0.9	275
20	1.78	1.9	23.0	15	0.95	360
24	2.0	2.1	27.2	15	1.05	490
30	2.0	2.3	33.6	15	1.15	690
36	2.0	2.5	39.6	15	1.25	920
40	2.0	2.7	43.7	15	1.35	940
42	2.0	2.7	45.7	20	1.35	1230
48	2.0	3.0	52.0	15	1.50	1290
48	2.0	3.0	52.0	20	1.50	1620

12 CAPS.

12" and 18" caps have two ribs. 16", 20", 24", 30" and 36" caps have three ribs. 40" and 48" caps have four ribs.

Diam. of Pipe.	DIMENSIONS IN INCHES. a	b	c	d	e	f	g	l	t	r	Weight.
3	1.8	1.80	—	4.5	0.41	—	—	3.25	0.84	—	18
4	1.8	1.80	—	6.8	0.65	—	—	3.25	0.84	—	35
6	1.8	1.80	—	8.8	0.74	—	—	3.25	0.84	—	46
8	1.8	1.80	—	10.1	0.76	—	—	3.25	0.84	—	100
10	1.8	1.80	—	12.0	0.84	—	—	E	0.29	—	130
12	1.8	1.80	—	14.1	0.92	—	—	E	0.29	—	175
14	1.8	1.80	1.80	16.26	0.84	0.28	E	E	0.29	—	225
16	1.8	1.80	1.75	16.55	0.86	0.28	E	E	0.29	—	285
20	1.78	1.80	2.00	18.70	0.86	0.28	E	E	1.0	—	360
24	2.0	2.0	2.0	22.2	0.98	1.0	—	E	1.0	—	575
30	2.0	2.1	2.00	26.8	1.08	1.0	2.8	E	1.05	—	840
36	2.0	2.2	2.00	33.8	1.15	1.0	2.8	E	1.15	48	1140
40	2.0	2.5	4.00	38.1	1.35	1.25	2.8	E	1.25	48	1520
42	2.0	2.7	4.00	40.15	1.35	1.25	2.8	E	1.35	48	1870
48	2.0	3.0	4.00	46.0	1.50	1.50	2.8	E	1.75	96	2060

13 REDUCERS.



No. 1. No. 2.

No.	DIMENSIONS IN INCHES. a	b	c	d	e	f	r	y	l	t¹	t²	Class	Weight.
1	4	3	5	7	2	2	2	2	20	0.65	0.60	B	55
1	6	4	5.5	9	10.7	3	3	3	33	0.70	0.65	B	75
1	8	6	5.8	7	10.9	4	4	4	33	0.80	0.80	B	110
1	10	6	6.0	10	12	5	5	5	30	0.90	0.80	B	155
1	12	8	6.0	10	12	5	5	5	30	0.90	0.80	B	180
1	12	8	6.0	10	12	5	5	5	38.6	0.90	0.85	B	180
1	12	8	6.0	10	12	5	6	6	32	0.95	0.85	B	185
1	12	8	6.0	10	12	6	6	6	34.6	0.95	0.85	B	210
1	18	10	6.8	20	12	6	6	6	28.8	0.95	0.90	B	285
1	16	10	20	8	8	—	—	—	36	0.75	0.65	B	310
2	20	12	20	8	8	—	—	—	36	0.75	0.65	B	430
2	20	16	26	8	8	—	—	—	42	0.85	0.75	B	630
2	30	16	26	8	8	—	—	—	42	0.85	0.75	B	630
2	24	16	26	8	8	—	—	—	42	0.85	0.75	B	630
2	24	20	26	8	8	—	—	—	42	0.85	0.85	B	740
2	30	20	26	8	8	—	—	—	42	1.00	0.85	B	990
2	30	24	26	8	8	—	—	—	42	1.10	0.90	B	1000
2	36	30	32	8	8	—	—	—	48	1.15	1.10	B	1330
2	36	24	32	8	8	—	—	—	48	1.00	0.95	A	1340
2	40	30	32	8	8	—	—	—	48	1.15	0.95	A	1480
2	40	36	32	8	8	—	—	—	48	1.15	1.00	A	1675
2	42	36	32	8	8	—	—	—	48	1.25	1.00	A	1980
2	48	42	32	8	8	—	—	—	48	1.25	1.15	A	2150

Standard Dimensions and Weights of Cast Iron Pipe and Special Castings; Boston Water-Works.

WILLIAM JACKSON, City Engineer.

iron stand-pipe, which was nearing completion when the writer arrived to take charge of the works.

A 6×6-in. angle iron, with the horizontal leg turning outward, was fastened to the lower end of the pipe, which rested on a masonry foundation without any anchorage, and without any bottom, the latter being replaced with an internal layer of cement concrete about 1 ft. thick. The parties who furnished the material say that they "gave the contractor a price for the complete structure, which was afterward reduced in consequence of leaving out the iron bottom, which was his own suggestion."

The concrete bottom did not prove to be water-tight, and was taken out. The next move of the builder was to pick out a recess under the bottom of the angle iron, and pour a lead joint entirely around the outer circumference, expecting to be able, by calking, to make a tight joint between the metal and the masonry. A might have been expected, this was a lamentable failure, and recourse was had to a new layer of concrete. Before this was in condition to use, the contractor deposited, with disinterested parties, a sum

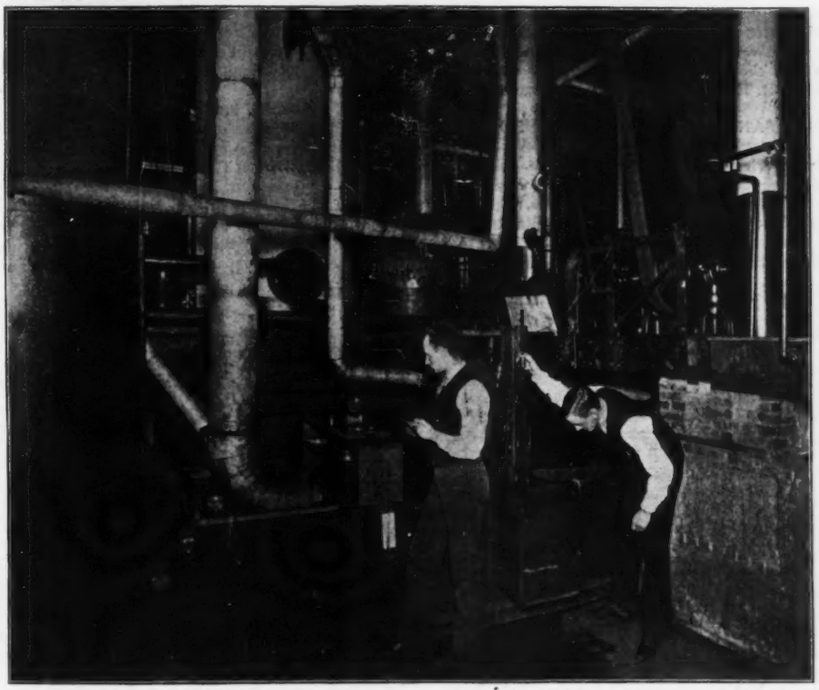


FIG. 5. STUDENTS TESTING A SWAIN TURBINE.

of money sufficient to provide an iron bottom in case the concrete was not satisfactory or did not remain tight for a period of six months, and, having in the meantime disposed of his stock interest, retired from the scene, stating, however, that he was going to arrange for the immediate putting in of an iron bottom, in order to release the funds deposited. Nothing further was heard from him, and the six-months clause turned out to be merely a device to embarrass the company in the use of their property, but, in due time they gained possession, and the first question was how to complete the work in a water-tight and workmanlike manner.

The treasurer of the company was a lumber manufacturer, and, like the historic tanner, who believed that there was "nothing like leather," saw no reason why a wooden bottom would not be the correct thing, and proceeded to carry out his ideas, although the writer did not approve of the device. This proved to be one of the few cases where the "practical man" has scored an apparent victory over the engineer.

The bottom was made of two thicknesses of 3-in. yellow pine plank, laid parallel and so as to break joints, all joints being filled with oakum, and then coated with pitch. The surface of the concrete was leveled up with a bed of cement mortar, on which the bottom layer of plank was bedded. Short braces, bearing against the bottom of the second course of sheets, were put in, to keep the bottom from floating until it became thoroughly water-logged. The leakage has been slight, and has not varied to any perceptible extent, except for a short interval after refilling the stand-pipe, when it has been emptied for any purpose.

Inasmuch as the expense was less than one-fourth of the sum required for an iron bottom, the experiment was a financial success, and the members of this association are probably well aware that such results appeal far more strongly to the heart of the average capitalist than any amount of abstract theorizing from an engineering point of view. The prospective removal of the structure to a different location is anticipated with pleasure, as it will give an opportunity to complete it in accordance with long tried and approved methods.

In adding 20 ft. to the stand-pipe, the inside staging having been removed, and the outside one being considered unsafe, the extension was erected from a float containing a balance derrick, which enabled the sheets of a course to be raised and swung to the proper position in a very expeditious manner. The rivets were driven on the inside, and held on the outside by a workman suspended in a cage carried by roller hooks traversing the top edge of the course of sheets on which work was being done. The riveting of the course having been completed, the seams were calked, and water then pumped in until the float was raised to the desired height for another course. This method of construction has the advantage of testing the work as fast as completed, and the writer believes this to be the first time the method was used. It has been in frequent use since, and is of great advantage where the pumping machinery and connections are completed before the stand-pipe is erected.

UNIFORMITY IN DESIGNS FOR SPECIAL CASTINGS.*

(With inset.)

By Dexter Brackett, M. Am. Soc. C. E.

In the specifications for water pipes the thickness and weight are generally prescribed, and variations of more than from 3 to 4% from the weights called for are not allowed. Special castings, however, are generally furnished of such patterns as the contractor may have in stock whether they be large or small, thick or thin, and as they are furnished by the pound the tendency is to have them both large and thick. Even in cases where the castings are made from drawings furnished by the engineer or superintendent, there is a great difference in the weight of the castings furnished by different foundries from the same drawing.

As special castings cost about double the price per pound of the straight pipe, they should be made of as compact forms as is consistent with their convenient use, also taking into consideration the question of their influence upon the flow of the water in the mains. The frictional head lost in a branch is, under most circumstances, but a very small fraction of the loss in the straight pipes; but under some circumstances, such as the branches supplying hydrants, elevators and motors, the difference in the discharge of a branch constructed so as to give an easy flow and one of the opposite form would be appreciable. This is well illustrated by sections of two branches, both made from the same drawing, but cast at different foundries. In one case there is a smooth, well rounded approach to the branch, while in the other the opening is contracted, rough and nearly square edged.

Another point which appears to me to be worthy of consideration is the advantage of having special castings of uniform pattern. Under the present system the branches of the same size are of varying dimensions and the curves of different radii and curvature. The pipe founders are often required to furnish castings of special design, causing delay and expense on account of patterns which must be made, when the standard forms would be equally serviceable if it were known that they could be furnished by the different foundries. These preliminary remarks will explain my motive in presenting for your consideration and use the following designs for special castings (Figs. 1 to 13 on the inset sheet). They are the standards adopted by the Boston Water Department; and the principal foundries furnishing pipe to New England are already supplied with many of the patterns. The dimensions of the bells and spigots are applicable to all of the special castings. The general dimensions of the different patterns are given below the details. The thickness of the castings, unless otherwise specified, agrees with the standard for pipe of the same internal diameter.

The designs are not claimed to be better than others which may have been or can be made, but they are thought to be of as compact form and light weight as it is advisable to adopt. The reducers and offsets have a bead cast back of the bell so that the bell can be cut off, leaving a bead on the end of the casting. This plan has been adopted to avoid a multiplicity of patterns, but if desired the castings could be ordered without bells.

The design for Y branches is one which has been used in Boston for the past 20 years with the best of results. Y branches are apt to be deficient in strength, but I do not know of the failure of one of this design.

As to the limit of variation from the standard weights which should be allowed, it seems to me that a variation of 4 or 5% should be the requirement of our specifications.

*A paper presented at the annual meeting of the New England Water-Works Association, June 15, 1893. The paper, with discussion, will be published in the Journal of the New England Water-Works Association.

RAILWAY IMPROVEMENTS FOR THE WORLD'S COLUMBIAN EXPOSITION TRAFFIC.—IV.

Chicago Great Western Ry.—Many improvements have been made in tracks, signals, etc., and the Chicago terminal, being already one of the finest and largest in the United States, and being constructed with an idea of taking care of increasing business, is at the present time large enough to answer fully the requirements of the Exposition traffic. No signal plant is being put in at present. This road has a 999 years' lease of the Chicago terminal facilities in connection with the Chicago & Northern Pacific R. R., and has equal rights with that road at what is known as the Grand Central station, corner of Harrison St. and Fifth Ave., referred to in our issue of June 8. In case it is necessary to run trains to the Exposition grounds, arrangements will be made with the Chicago & Calumet Terminal Co., owned by the Chicago & Northern Pacific Co. The Chicago Great Western Ry. uses 10 miles of double-track road out of Chicago, and also uses double-track road east of Dubuque for 13 miles. The road has all the equipment it will need during the coming summer, as it has been added to during the past year in order that the road might be fully in shape by the time the Exposition was opened. In the way of excursions, it is expected to run excursion trains over the line about twice a week, or oftener if occasion requires it. The train service on the regular card has not been increased for the Exposition business, it being the intention to run extra sections of regular trains wherever it is found necessary to do so. There are already two trains daily to and from St. Paul and Minneapolis, and two daily trains to and from Des Moines, St. Joseph, Leavenworth and Kansas City. When extra business develops, a sufficient number of extra sections to these trains will be run to accommodate the people. We are indebted to Mr. James Egan, President and General Manager, and Mr. F. H. Lord, General Passenger Agent, for the above particulars. The road has no exhibit at the Exposition.

Chicago, Burlington & Quincy R. R.—Mr. W. F. Merrill, General Manager, informs us that there have been added to the equipment of the Burlington system within the last 18 months, 113 locomotives

and 126 passenger and chair cars. This company owns no sleeping cars. This equipment, with the additions that have been made in track and terminal facilities, has been partly to cover the requirements for the World's Columbian Exposition, and partly in anticipation of the future. It is not expected to run any trains into the Exposition grounds. The C., B. & Q. R. R. has no exhibit at the Exposition; there is a car there marked "Burlington," but it belongs to the Jackson & Sharp Co., and is exhibited by that company. The Chicago terminal is in the Union passenger station, which is owned and controlled by the Pennsylvania company, the Burlington company only having a leasehold right.

Chicago & Northwestern R. R.—This road has made preparations for a heavy traffic. It built about 200 passenger coaches last year, and 50 engines were also built last year in anticipation of the summer's business. The block signal system has been adopted on 90 miles of its tracks entering Chicago, and a large amount of money has been spent in relaying tracks and putting in interlocked crossings over other railways. It will have a double-track road between Chicago and Milwaukee, and a second track will be constructed on the Wisconsin division, between Des Plaines and Barrington. The excursion business will be handled largely by special trains, special territory being given certain days. The trains will arrive at Chicago mostly in the morning, before the rush of the regular through and suburban traffic begins. The present intention is to run all suburban business into the main terminal station at Wells St. rather than handle it over the roundabout route to the Exposition grounds. It is believed that most passengers will prefer being landed down town early in the morning, giving them time to find their rooms and have their baggage delivered, rather than to go direct to the grounds. At the Northwestern R. R. terminal station, a long trainshed has been built for the accommodation of the suburban traffic, which monopolizes to so large an extent the terminal facilities of the road, and when thus relieved from a large part of the suburban traffic it is thought the station can accommodate the Exposition traffic by arranging for the arrival of extra trains at times when the regular business will be comparatively light.

Boston & Albany R. R.—Mr. A. S. Hanson, General Passenger Agent, states that a considerable through traffic is expected and additional through sleeping cars have been put on three of the through trains from Boston to Chicago. There are now six trains having through cars from Boston, the cars running from Buffalo over both the Lake Shore & Michigan Southern Ry. and the Michigan Central R. R. The special tariff for excursion tickets to Chicago, and return, is $32.50, $44, or $46.50, according to whether the tickets are limited or unlimited.

Cleveland, Cincinnati, Chicago & St. Louis Ry.—This road, which comes into Chicago over the Illinois Central R. R. from Kankakee, has purchased for the handling of its extra Exposition business 44 coaches, 2 dining cars, and 10 large passenger engines. By May 1 three miles of double track and 11 miles of lap-passing sidings on the Chicago division for rapid handling of trains were completed, at an estimated cost of $150,000, and in addition the Chicago division has been laid with 80-lb. steel rails in place of 60-lb. rails. It is estimated that the aggregate outlay on the Chicago division and for new equipment, all on account of the Exposition, has not been less than $400,000.

Mr. D. B. Martin, General Passenger Agent, informs us that the traffic since the opening of the World's Columbian Exposition has become so heavy over the various divisions of the "Big Four" route that it has been necessary to add three additional trains between Cincinnati, Indianapolis and Chicago, making in all five fast trains in each direction, leaving terminals at the most convenient hours of the day. In addition to these, solid through trains are run from Columbus, Dayton and Springfield, and from Washington, D. C., over the Chesapeake & Ohio Ry., and from Macon and Atlanta, Ga., over the East Tennessee, Virginia & Georgia Ry. and Cincinnati Southern Ry. (Queen & Crescent route) via Chattanooga.

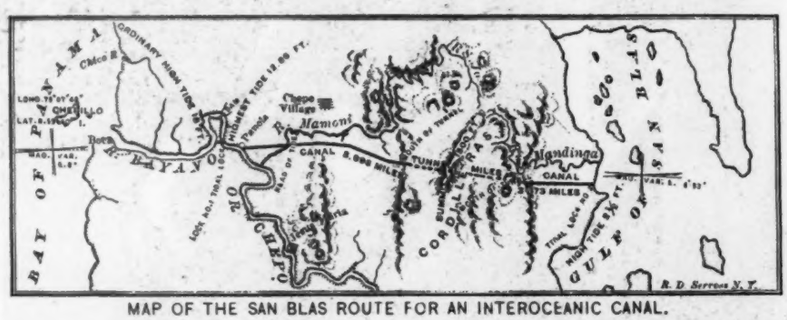
As a matter of equipment these trains are said to excel anything ever offered by any line from the south and southeast. The day trains have every modern equipment in elegant coaches, parlor and cafe cars, and hotel dining cars. The night trains have Wagner sleeping cars, private compartment buffet sleeping cars, reclining-chair cars and coaches with comfortable high-backed seats. These trains are vestibuled throughout, and are lighted by the Pintsch compressed gas system.

The reasons that the traffic should be so heavy and the extra equipment so complete are given as follows: All trains from the south and southeast connect at Cincinnati in the Central Union Station with all trains of the Cleveland, Cincinnati, Chicago & St. Louis Ry. (Big Four route), avoiding tedious transfer across the city, which is necessary with other lines. All the trains of this route pass directly by the Exposition grounds, and stop at the Midway Plaisance, the main entrance, thus avoiding transfer at Chicago. There are a number of hotels along this route, and convenient stops are made from Kensington, Ill., to Chicago, to accommodate visitors to the Exposition. Other convenient stops are made at Hyde Park, Thirty-ninth St. and Twenty-second St., Chicago, and the trains run into the new terminal station of the Illinois Central R. R., as mentioned in our issue of May 4.

THE SAN BLAS SHIP-CANAL PROJECT.

By Amos G. Hull.

Engineering skill with the requisite amount of capital can build a canal at Panama without doubt, but it begins to be feared by engineers, which fear is no doubt pervading the minds of capitalists, that the eternal and unchangeable laws of nature in that peculiar region would soon destroy its permanency. What is to be done? Will commerce fold her wings at the sight of a little isthmus 30 miles wide which separates the two great oceans of the globe? Commerce was never so hopeful and active as at the present moment, and will not permit her ships to sail 14,000 miles to avoid an obstruction of 30 miles in width. That obstruction must be got out of the way for the passage of her ships, and it will be.



MAP OF THE SAN BLAS ROUTE FOR AN INTEROCEANIC CANAL.

The advantages of a ship canal uniting the waters of the Atlantic with those of the Pacific are incalculable and have never been disputed. The literature upon that subject is very extensive, and was published broadcast about 11 years ago, and awakened deep public interest. It is not proposed to republish it here. On the occasion of the great banquet in honor of de Lesseps, March 1, 1880, at which a large number of the prominent citizens and leading merchants and commercial men of New York were present, remarks were made as to the choice of the two proposed routes, the San Blas and the Panama. Mr. de Lesseps is reported to have said that a railroad having already been built near the proposed route would be quite a consideration in the moving of supplies and materials. He emphatically declared "that the United States have by right the pre-eminence in the enterprise, and it is my conviction they will secure it. Science has declared that the work is possible, and I am the servant of science. I will carry this work to a successful result and it will make America Queen of the Seas."

Among the speakers at that banquet was a highly respected citizen of New York, Mr. Frederick M. Kelley, who made an eloquent, lengthy and instructive address. He had always favored the San Blas route. No man living more thoroughly understands the geography, geology and topography of the Isthmus of Darien than Mr. Kelley. He has spent more than 27 years of an active life in a survey of that isthmus. He has spent a large fortune in the work and has equipped and sent out at his own expense seven different surveying parties of skilled and competent engineers to explore and find the shortest and most feasible route between the oceans. He is firm in his conviction that the San Blas route is by far the cheapest and best.

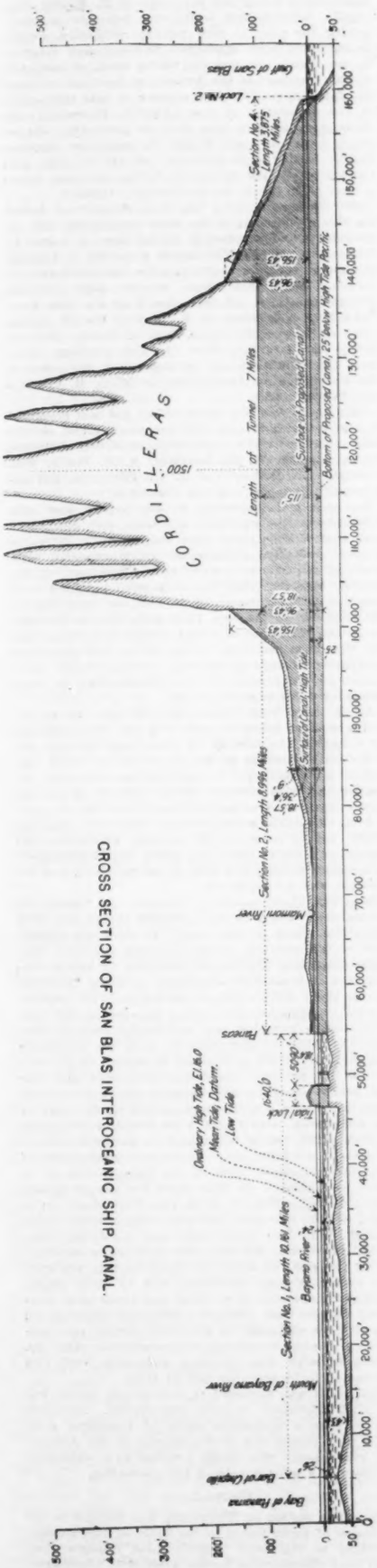
But the Panama ship canal is unconstructed and must forever remain so as a sea-level canal in the judgment of eminent engineers, unless some convulsion of nature shall sweep away the Rio Chargres. What shall be done? There is a short route, claimed to be a feasible route, for such a canal which has not been tried.

De Lesseps said as long ago as 1879, in discussing the question with Mr. Walton W. Evans: "There is one point in this matter we must observe whenever the canal is built—it must be a sea-level canal." De Lesseps entered upon the work at Panama, no doubt, with honest and the most sincere intentions. But it must be remembered that he is not an engineer. He had, however, been told by Mr. Evans, who knew the isthmus well, that the Panama as a route for a sea level canal was simply ridiculous. De Lesseps has found it out now to his great regret.

The blunders and loss at Panama have disgusted the public, but some of this loss can be retrieved. Why not remove the machinery and materials and plant 40 miles down the isthmus to a point where there is an excellent harbor upon a route where many of the best engineers in the land say that a ship canal upon an ocean level can be opened for one-half the money that has been lost in the unfortunate Panama experiment? The Panama Canal Co. already owns a concession on this San Blas route. If the company should resume operations on this new route, our government would very probably make an appropriation providing for a new and verified survey thereof with the view of having the work commenced immediately.

Mr. Walton W. Evans, in speaking of the San Blas route, says: "I am glad to find that all the old canal engineers that have ever visited the isthmus and made a study of the problem, join me in the opinion that the San Blas route is the best for a sea-level canal, and the proper one to construct, and Mr. Frederick M. Kelley, who has spent his life and a fortune in surveys and study of this matter, and who has as clear an understanding of the whole subject as any man living, also most enthusiastically gives his adherence and support to that route as the only one that can satisfy the coming demands of trade."

On May 9, 1879, at Berlin, in a letter to M. C. Auguste Von Hernest, on this canal question, Mr. Evans said in substance: "Were I king and no one to say nay, I would first make complete surveys of the two routes, the Caledonia Bay Route and the San Blas Route, to find which was best as to length of tunnel and other points, such as harbors and drainage. Second, if I found the San Blas route the best of the two, I would buy the Panama Railway and its concessions of all kinds. Third, I would get a concession from the Colombian government, allowing me to build the canal. Fourth, I would locate a direct straight line on the shortest route from San Blas to Pacific Ocean. Fifth, I would send for M. Favre, contractor for the St. Gothard tunnel, who has more experience in great tunnels than any man now living, and make a contract with him or some arrangement for the use of his brains or experience. Sixth, I would call together a committee of merchants, shipowners and engineers, to decide on the dimen-


CORDILLERAS
Section No. 1, Length 8.996 Miles
Section No. 2, Length 7 Miles
Section No. 3, Length 12.81 Miles
Section No. 4, Length 3.875 Miles
Length of Tunnel 7 Miles
Surface of Proposed Canal
Bottom of Proposed Canal, 25' below High Tide Pacific
Mamoni River
Bayano River
Bay of Panama
Delivery High Tide, El. 45.0
Mean Tide, Datum.
Low Tide
Lock No. 2
Lock No. 3
Lock No. 4
Lock No. 5
Lock No. 6
Lock No. 7
Lock No. 8
Lock No. 9
Section of Canal, High Tide
CROSS SECTION OF SAN BLAS INTEROCEANIC SHIP CANAL.

sions of the canal and tunnel. Seventh, I would drive this work night and day until it was completed and thrown open for the benefit of the world. Eighth, I would call on the government of England, France and the United States, to guarantee the bonds of a company to the whole amount of estimated cost; these governments to become the owners of the canal at the end of 100 years, they paying original costs as determined by a board of their own, during construction. Ninth, I would insist on the whole work being completed within eight years."

The leading advantages of the San Blas route over any other proposed, may be said to be: First, It has fine harbors at its termini. Second, It is the only feasible sea level route known. Third, It is the shortest and not an unhealthy route.

As to harbors: A very distinguished American citizen, the President of the American Geographical Society, the ex-Chief Justice of one of our highest courts, a gentleman who has spent years in careful geographical study, said at a meeting of that society, in December, 1879: "It is well known to geographers, at least to all American geographers, that the Bay of San Blas is a very remarkable one, and that in the northwest portion of that bay, at the mouth of the Mandingo River, which is near the mouth of the projected canal, there is a very fine harbor capable of accommodating vessels of any depth of draft."

From an interesting address delivered by Maj. Sidney F. Shelbourne, before the American Geographical Society, in 1879, we learn that the San Blas harbor has a depth of water along its northwestern boundary of 112 ft., and as you pass inward toward the delta between the mouths of the Rio Mandingo you have a depth of 30 ft. within 900 ft. of the shore. The bottom of the harbor is of clay and stiff mud, affording excellent holding ground.

The Mandingo harbor, embracing an area of about nine square miles, is intended to be the Atlantic terminus of the San Blas Inter-Oceanic Canal. The harbor on the Pacific side is deep, sheltered and commodious. We learn further from Major Shelbourne's address that on the Atlantic side the terminus of the canal would be in latitude 9° 26″ north and longitude 79° 2″ west.

The first section of the canal would be four miles of open cutting in a generally southwest direction; then would follow a tunnel of seven miles through the Cordillera, varying but little from a meridian of longitude, terminating on the Pacific slope of the range about half a mile east by northeast of the falls of Salto. From this point the canal would be, by an open cutting, 12 miles into the Rio Bayano at its great bend, a point six miles from the Bay of Panama, thence along the river to the harbor.

At a meeting of the American Geographical Society, held in New York in December, 1879, Mr. Kelley, in speaking of the San Blas route, said: "My efforts have been to find a canal route practicable without locks, and I believe the San Blas is the best of all, because it is the shortest. Ships should be enabled to go through on an even keel. They require good harbors with no necessity of dredging to keep them open. Ship captains and shipping merchants in this country and Europe are all agreed in that respect. On the San Blas route the total distance through is about 30 miles. Ten miles of the river Bayano is suitable with but little improvements for navigation, and of the remaining 20 miles seven is a tunnel. The question is not so much one of cost as one of commerce and facility of use. What are $30,000,000 or $50,000,000 more or less in a work of this kind which is to last forever, and accommodate the expanding needs of trade. There is a great deal in having a canal that will be easy to maintain; a tunnel 80 ft. wide at the water surface and 120 ft. high above the canal bottom, to crown of arch is sufficient. A ship can pass this route in 10 hours, towed at the rate of three miles an hour; to pass the Nicaragua route at the same rate would require 64 hours.

Fears have been expressed that the rock through which it is proposed to cut the canal might be of such fragile character as to require that the tunnel should be lined in order to be safe and durable. But Engineer Charles A. Sweet, a very intelligent, careful and conscientious man, who made the survey of the San Blas route, in 1864, in his official report of the survey, says that the nature of the material through which excavation is to be made is substantially the primitive rock and of so substantial a character that no provision for lining is necessary.

The dip of the rock on the South or Pacific side of the Cordilleras is 33° in a southerly direction, and on the north or Atlantic side it was found to vary from 20° to 30° in a northerly direction. The location of the anti-clinal axis seemed to be at the summit. On the plains of Madrono, near the Mamoni River, the granite crops out at an elevation of 550 ft. above sea level and at 600 ft. it is again covered by the trap formation. The direction of the dip, above mentioned, seems to be favorable for intercepting the granite in the tunnel after passing through the trap which overlies it. The following letter, written in 1864, to Mr. Sweet, by Mr. C. Chemisard, a prominent geologist, residing at the time in the city of Panama, is now printed for the first time:

Panama, May 16, 1864.

Sir—A few words on the geological peculiarities to be seen in the Bay of Panama. First, The ledge of rocks which spread seaward from the face of the walls of Panama are formed of numberless strata of mangrove petrifications, and have a general dip of about 30° to the southeast. Second, The several strata of lime formation in the Pearl Islands have a dip toward the south, and with about the same angle. Third, Under Chepillo Island the seaward dip looks toward the south. Taking these facts into consideration one might be inclined to think that the great Panama Bay was formerly dry land, which, in the heaving up of the Isthmus, has been submerged, leaving the open sea as at the present day. On the northeastern part of Chapera Island one of the Pearl Islands, the dip of the strata on a cursory observation seems to be greater than 30°, and over the edges of the inclined strata there is a ledge of horizontal formation at present out of the reach of the spring tides by about five feet. This ledge is formed by a succession of layers of carbonate of lime, in which are embedded petrified trees, branches and roots of the mangrove species. There one may conceive that after the tumbling down of the lower strata dipping to the southwest a succession of new horizontal deposits of carbonate of lime have taken place upon which have grown the now decayed and petrified mangrove trees, and that a regular vertical upheaving of the primitive granite formation below has carried up the horizontal deposit, along with the inclined ledge mentioned to their present position.

Engineer Charles A. Sweet thinks it will require from six to eight years to construct the canal and submits the following estimate of cost on the San Blas route:

Lighthouse at Chepillo Island	$12,000
Removal of bars in Pacific harbor and in Bayano River	136,684
Tidal lock at Great Bend	675,844
Dam across river at "	174,631
Cut at "	209,835
New channel for Mamoni River	115,752
Canal to south end of tunnel	13,033,943
Tunnel, 7 miles long	57,103,200
Canal to Gulf of San Blas	11,234,313
Lock, 9 ft. lift at San Blas	506,017
Lighthouse on Butler's Point	12,000
Engineering and contingencies, 25%	20,803,556
Total estimated cost	$104,017,780
If tunnel requires lining throughout, add	32,002,181
Total cost in this case	$136,019,961

There are two plans for crossing the isthmus, the lock plan and the sea-level plan. The former is the Nicaragua route. The sea-level is the San Blas route. Both have their advocates. The necessity of commerce may eventually construct them both. The largest ship will take the sea-level route because it is so much shorter and by some it will be deemed safer, and because it has fine, deep natural harbors at its termini.

The objection to the San Blas route hitherto has been the tunnel. But since modern inventions in explosives and machinery have revolutionized the old modes of tunneling, that obstruction has ceased to be a terror to modern engineering. European commerce has tunneled the Alps, and American enterprise will not pause and be turned back in its march by the little Cordillera, whose attitude is but 1,500 ft. The Nicaragua route was carefully surveyed and mapped by that eminent engineer Orville W. Childs, in 1850 and 1851. He planned for locks of 10 or 12 ft. lift. It was designed at the time more particularly for vessels of light draft and as a route for passengers between the Atlantic and Pacific coasts. Forty years and more have rolled by and it remains unconstructed. Naval men do not seem to take kindly to the projected

plans of that route, and they characterize the locks as a water staircase. The Hon. Warner Miller, who, with his usual zeal, is pushing the Nicaragua project, predicts that the present century will see it done, and if his predictions prove true it will place his name on the roll of distinguished public benefactors. But with his enterprise fully under way, the advocates of the San Blas route will come to the front with their enterprise, and they will build it, for commerce will find abundant business for both routes, and the wonder will be that two such important enterprises were so long delayed.

(In Engineering News of Sept. 13, 1879, Mr. Charles A. Sweet, the engineer referred to in the above article by Mr. Hull, gives some further data on the San Blas route, and the map here reproduced. From this letter we make the following brief abstract: The total length of the proposed canal is 30.3 miles. Commencing at the west or Pacific side, the River Bayano can be made available for canal purposes at a "nominal cost" for 10.1 miles; the cutting that would follow is through a comparatively level and healthy country. The depth of cutting at the west end of the tunnel would be 150 ft. and the distance is 8.99 miles. The summit of the Cordillera Range penetrated by the tunnel is 1,500 ft. above sea-level. The formation is principally trap and granite, and the tunnel will apparently need no lining.

The dimensions of the canal proposed, outside of the tunnel, are 100 ft. wide on bottom, 125 ft. wide at surface and 28 ft. deep. The tunnel section was 70 ft. wide at bottom; a batter of 1 in 12 outward for 54 ft. in height to the spring of a gothic arch. The total height of tunnel would be 118 ft. from bottom of canal to crown of arch, or 90 ft. high above the water. This section contains 845 sq. yds.; or 282 cu. yds. per lin. ft.

In estimating the cost of the tunnel, Mr. Sweet assumed a heading of 243 sq. ft. at $20 per cu. yd., and figured the removal of the bottom at $5 per cu. yd. This amounts to $1,545 per lin. ft. of tunnel. He estimated that it would cost an additional $865.88 per lin. ft. of tunnel to line, though he does not believe that this would be necessary under the apparent geological conditions. The total estimated cost of the canal and tunnel, lined and unlined, is the same as that given in Mr. Hull's paper.—Ed.)

PERSONALS.

Mr. A. W. Cooke has been appointed Chief Engineer of the Street Department, at Chicago, Ill.

Mr. John C. Wait has been appointed Assistant Professor of Engineering at Harvard College for five years.

Mr. William Bennett, Superintendent of Water-Works at Augusta, Ga., for several years, died recently.

Mr. Wm. P. Richards has been appointed civilian assistant to the Engineer Commissioner of Washington, D. C.

Mr. J. L. Brown has resigned his position as Master Mechanic of the Pittsburgh & Western R. R. to accept that of Superintendent of Water-Works at Allegheny, Pa.

Mr. Geo. W. Harrington has resigned his position of superintendent of the Wakefield (Mass.) Water Co., and will hereafter devote his time to the business of the New England Water Pipe Co., of Wakefield, of which he is treasurer and manager.

Mr. Walter McQueen died at Schenectady, N. Y., June 16, at the age of 76. He was one of the largest stockholders in the Schenectady Locomotive Works, and was Superintendent for many years, but had not taken any active part in the management of the works for a long while. Mr. Pitkin succeeded him as Superintendent.

Mr. Patrick J. Flynn, M. Am. Soc. C. E., died at Los Angeles, Cal., on June 1. He had spent eight years in India, and for 14 years was connected with city engineering works in San Francisco and later in Los Angeles. He devoted special attention to irrigation and was the author of a work on "Irrigation Canals and Irrigation Works."

Mr. John Ericson has been appointed Principal Assistant City Engineer of Chicago. Mr. Ericson has been connected with the city engineering department since 1884, and has had charge of the construction of the 60th St. tunnel and pumping station, as well as the Washington Heights plant. He was at one time Assistant Engineer of the Drainage Commission.

NEW PUBLICATIONS.

BIOGRAPHICAL DIRECTORY of the Railway Officials of America. Edition of 1893. Edited and Compiled by T. A. Busbey. Published biennially by "The Railway Age and Northwestern Railroader." Chicago, Ill. 8vo, 418 pp.

This is a very useful directory, as far as it goes, and on a rough estimate includes about 4,000 names. For these it gives a concise but sufficiently clear official biography with dates of appointments or service in various capacities. We have not been able, however, to decide where the line has been drawn as to official grade included in the scope of this directory. The names of assistant and division engineers appear at times, as well as those of railway solicitors, master mechanics and car builders, auditors, cashiers, etc. Including all of these the list would certainly be much longer. It is but natural that such a work should be somewhat incomplete, and the names of the chief engineers of some prominent lines that we happened to look for are omitted, but the scheme is a good one, and is well carried out in the manner of presentation.

IOWA SOCIETY OF CIVIL ENGINEERS AND SURVEYORS.—Proceedings of fifth annual convention, Jan. 8, 1893. Secy., Seth Dean, Glenwood, Ia. 8vo., pp. 76. Price, 50 cts.

In addition to the reports of committees, etc., and the address of the president, Mr. Wm. Steyh, this number contains the following papers: "Field Book of Tables," Seth Dean; "The Magnetic Needle," R. G. Brown; "Construction and Maintenance of Public Highways," Wm. Steyh; "Drainage and Road Improvements," F. L. Easley; "Better Roads," M. V. Ashby; "The New Road Law," L. Higgins and Seth Dean; "Good Roads and Their Maintenance," J. J. W. Billingsley; "Cost of Pile Driving," J. C. Sheely.

PAST AND PRESENT OF STEAM NAVIGATION ON LONG ISLAND SOUND.—Providence & Stonington S. S. Co., New York. 8vo., pp. 71. Illustrated.

This interesting pamphlet commences with the early steamers of Fitch and Fulton, about 1786, and refers to other early American experiments in steam navigation, and the "Clermont," the "Fulton," the "Chancellor Livingston" and other early steamers are illustrated and described. The growth of the modern type of Sound steamers is shown by views of steamers of different dates, with particulars of their service. The "present" is shown by descriptions of the present vessels of this company, which include the "Connecticut," with oscillating, compound engines for side-wheels, and the screw steamer "Maine" and "New Hampshire," described in our issue of March 12, 1892.

TABLES OF SQUARES FROM 1 to 10,001. Rochester Bridge & Iron Works, Rochester, N. Y. 8vo; blueprints; pp. 49. $1.00.

This publication was reviewed in our issue of May 18. Since then the publishers have written us that they have applied an independent check to each computation, and are now positive that only two errors exist in the tables. These are: Page 38, square of 7509 should read, 56385081; page 42, square of 8282 should read, 68591524.

TIDE TABLES FOR THE ATLANTIC COAST of the United States, Together with 207 Stations on the Atlantic Coast of British America. For the year 1894. Washington, D. C.: U. S. Coast and Geodetic Survey Office. Mr. T. C. Mendenhall, Superintendent. 8vo; paper; 253 pp.; $0.25.

TRADE PUBLICATIONS.

STEEL.—Crescent Steel Co., Pittsburg, Pa. 8vo; pp. 8.

This is a list of articles exhibited by the company at the World's Columbian Exposition, together with a number of testimonials of service of tools, etc., made from this steel. The exhibit is in the Mines and Mining Building.

PUMPING MACHINERY.—Henry R. Worthington, New York. 12mo; pp. 12; illustrated.

This pamphlet gives a concise description of the growth of the business in Worthington pumping engines, and has a map showing the location of the various engines exhibited at the World's Columbian Exposition.

ELECTRICITY.—General Electric Co., New York.

This is a World's Columbian Exposition folder, containing views of various Edison works, applications of electricity, etc.

SOCIETY PROCEEDINGS.

MASTER CAR BUILDERS' ASSOCIATION.—The 27th annual convention was opened at Lakewood, N. Y., on June 13. The first session was called to order at 9:30 a. m. by the President, E. W. Grieves, of the Baltimore & Ohio. After the rollcall, responded to by 63 members, Mr. Grieves made a brief address, reviewing the work of the Association and the progress of the past year, referring especially to the fact that the national safety appliance law passed at the last session had been made possible largely by the work already done by the Association. He also mentioned the progress made in the use of pressed steel in car construction, and the valuable information gathered by the discussion in the local railway clubs.

The secretary's report showed an increase in the membership during the past year of 23, divided about equally between the active and associate members. During the year 11 new railway companies, owning 28,402 cars, have appointed representative members in the association, and the rolling stock of companies already members of the Association has been increased by 22,189 cars. The total number of cars represented in the Association is now 1,123,339. Financially, the Association is in a high state of prosperity. Its receipts last year were $7,423; its operating expenses, $6,236; leaving "net earnings" of $1,187. This, plus the balance in the treasurer's hands last year, makes a total of $5,453 in the Association's treasury.

Miscellaneous business was then disposed of, including the appointment of the usual committees, and the assessment and payment of annual dues. A motion by W. H. Day, of the Wilmington, Columbia & Augusta, to limit all speakers to five minutes and forbid any one speaking more than twice on the same question, was put and lost. An invitation from the New York, Lake Erie & Western R. R. to visit the oil regions and the Prospect Hill stock farm of Messrs. Miller & Sibley, on Saturday, June 17, was accepted. After some other routine work was disposed of, the report of the Committee on Attachments of M. C. B. Couplers to cars was read.

This report was one of the fullest and best presented to the convention, and reflected much credit on the able committee which prepared it, consisting of Messrs. E. D. Bronner, W. H. Harrison, A. M. Waitt, Wm. Garstang, A. Dolbeer and J. H. Davis.. A full abstract of this report is given elsewhere.

The principal discussion on this report was with reference to the statement that cars with deadblocks and weak draft rigging were coupled on a 38° curve without difficulty, a statement which appeared little short of miraculous to some of the members. It appeared, however, that the cars were equipped with couplers designed especially to work on sharp curves. Mr. Mitchell, of the New York, Lake Erie & Western, said that the Erie cars had double deadblocks and the Erie lines had many sharp curves, and there was no trouble in making couplings. It was finally voted to submit the committee's recommendations to letter ballot for adoption as standards.

At the noon hour topical questions were called for, and a member asked whether if a car were destroyed by a cyclone the railway on whose road the car was would be responsible to the owner for it. There was general agreement that he would be so responsible, according to the Interchange Rules, although in law the owner might have to bear the loss as an "act of God." Mr. A. B. Allen asked whether worn-out knuckles should not be classed with worn-out brakeshoes and brasses as a defect which the owner should make good. It appeared to be a new idea to the members, and the question was not answered.

Secretary Cloud presented a report on "Metal for Brakeshoes," which he had prepared in the lack of a committee report on that topic. To show the importance of the question, he had collected statistics from roads controlling 320,000 cars, showing an annual consumption of brakeshoes amounting to about 32,000,000 lbs., or about 100 lbs. per car per annum. This indicates a total consumption per annum of about 55,000 tons of brakeshoe metal on cars and engine tenders. Perhaps two-thirds of this metal is worn out in service and the other third is returned as scrap. Of the 32,000,000 lbs. reported, about five-sixths was cast iron and nearly one-sixth was Congdon shoes. The roads reporting, which control about one-fourth the cars in the Association, also reported an annual consumption of about 1,025 tons of brakeshoes on engine drivers.

To these statistics some particulars were added of the results of recent tests on the Pennsylvania R. R. These tests showed: (1) That there was practically the same braking efficiency with two brakeshoes on a wheel or with one shoe, the same total pressure being applied. With two shoes there was somewhat more sliding of wheels, but the cars rode more smoothly during the stop; (2) about the same braking efficiency was shown by long brakeshoes and by short brakeshoes, with one shoe to a wheel and equal total pressures; (3) cast iron, composite and steel shoes varied in resistance and wear in the order named, cast iron showing greatest resistance and most wear. The difference in wear was especially noticeable, cast iron wearing 10 to 14 times as fast as steel.

This report was discussed at considerable length, but not much information of value was elicited. The question whether a systematic series of brakeshoe tests under the auspices and at the expense of the Association was feasible was finally referred to a committee to report at a later session of the convention.

Wednesday.

The whole session on Wednesday was devoted to the discussion of amendments to the Rules of Interchange, according to the usual custom. Less changes than usual were recommended by the Arbitration Committee, and the Convention proved quite as conservative as in

the past toward the few changes which were proposed.

The only changes of really great importance were made in the rules governing the repairs of broken couplers. During the past year the rule has been that a road breaking an M. C. B. coupler on a foreign car might put any link-and-pin bar in its place, and the owner of the car was obliged to give credit for the full value, new, of the link-and-pin bar. But under the rule as amended by this Convention there is no longer premium on the practice of substituting a link-and-pin drawbar for a broken M. C. B. bar. The company which does this gets credit for the bar which it puts in only at scrap rates, and it has to pay the owner of the car the full value of the broken M. C. B. drawbar. The rule adopted last year that one M. C. B. drawbar can be substituted for any other M. C. B. bar in repairs still stands, so there is no longer any object for a railway company to repair drawbars with any other than the proper material.

A change of still more importance has been made in the rule regarding repairs of broken link-and-pin drawbars. Any one breaking a link-and-pin drawbar on a foreign car may put any link-and-pin drawbar in its place provided it fits properly, is sufficiently strong, and is in good condition. Thus a cast bar may be substituted for a malleable or wrought iron bar, and the owner of the car must accept it. The change does away in fact with the perpetuation of all the numerous standards for link-and-pin bars which various roads have so long clung to, and vastly simplifies running repairs on cars. This is the third year that an attempt has been made to get this change through the Convention. Each previous year it has encountered strong opposition, but the passage of the National Safety Appliance law has put a new face on matters, and the change this year was made without opposition.

The other changes made in the rules were as follows: The limits in the diameter of the wheel seats of axles were reduced ⅛-in. on the 50,000 and 40,000 lb. sizes, for the purpose of permitting the axle to be refitted to a new pair of wheels once more without reducing its marked capacity. "Hand-holds in bad order or insecurely fastened" was added to the list of defects for which cars may be refused, in accordance with the Safety Appliance law. The "partial repair" card, which has been several times discussed by the Association, was inserted in the rules in a modified form, inspectors being instructed to use separate defect cards to cover running repairs, especially airbrake work and work on brake attachments. There has been some controversy as to whether private car companies should be charged for the labor of renewing worn out brakeshoes and journal bearings on their cars. Rule 10 was so changed as to definitely settle that no such charges are to be made. The prices for cast iron wheels were revised, the new schedule being as follows:

Size of wheel.	New.	Second-hand.	Scrap.
36 in.	$10.00	$7	$4.50
33 in.	8.50	6	4.00
30 in. (or less)	7.00	5	3.50

The price of second-hand axles of 40,000 lbs. capacity or less was reduced from $6 to $5.50.

The amendment to Rule 16, referred to above is:

Any company finding a link-and-pin drawbar in a car originally equipped with a drawbar of the M. C. B. type and so marked and carded for wrong material, may replace the link-and-pin drawbar with an M. C. B.. drawbar and bill upon the card to the railroad company carding the car for the wrong drawbar.

In the rule referring to splicing of sills a clause was added forbidding the splicing of two adjacent sills between cross-tie timbers. The prices for materials and labor were altered and the prices for materials are now as follows:

Material.	Charge.	Credit
Cast iron, per lb.	1½ cts.	¾ ct
Malleable iron, per lb.	3¾ "	½ "
Bolts, nuts and forgings, per lb.	4 "	1 "
Steel castings, per lb.	6 "	¾ "
Spring steel (not springs), per lb.	5 "	¾ "
Brass or bronze journal bearings, per lb.	13 "	9 cts.
Lumber: Yellow, white and Norway pine, poplar, oak, hickory and elm, per ft.	3 "	....
Labor, per hour	20 "	....
1 box or stock car side door, applied	$5.00	....
1 box car ventilated side door, wooden frame with iron rods.	8.00	....
1 box or stock car framed end door	3.00	....
Chain, per lb.	5 "	1 ct.
Air brake, hose and coupling complete, applied.	9.00	....

A price is also to be fixed by the Executive Committee for M. C. B. couplers with strap and with tail bolt, and will be inserted in the table. The price of air brakes was changed from $50 to $40. An amendment was adopted to the rules providing for the return of trucks to the owner freight free by a company destroying the body of a car. The amendment provides that delivery shall be made to the nearest point on the line of the company operating the car. Another amendment provided that special stock cars destroyed by accident should be settled for at prices to be fixed by mutual agreement instead of at a fixed price of $20 each for feeding and for watering attachments.

The last changes made were some unimportant alterations in the rules regarding the duties of the Arbitration Committee and the voting powers of members in revision of the rules.

One or two proposed changes to the rules which were defeated gave rise to some interesting discussion. Mr. Chamberlain, of the Boston & Maine, proposed to amend the rule which provides that "brake beams, levers and attachments shall be not less than 2½ ins. above the top of the rail," so that 2 ins. height should be permissible. The exciting cause of this amendment appeared to be that the New York, New Haven & Hartford had set to work to rigidly enforce the rule, whereas common practice appears to be to pass it over, and so long as the brake rigging clears the rail an inch or more it is passed by the inspectors. Messrs. Adams, of the Boston & Albany, and Leeds, of the Louisville & Nashville, declared that if this rule were rigidly enforced, half or more of the cars passing over their roads would be stopped. On the other hand, it was urged that any legalizing of the practice of hanging brake gear very low was a move in the wrong direction. Mr. Marden said that on the Fitchburg road, in a single month, 40 cars arrived in Boston with the brake gear torn entirely off, on account of the brakes being hung too low and the brake heads getting under the wheel. These figures were so strong an argument against the proposed change that it was easily defeated.

An interesting point brought out in this discussion was that brakes ought to be hung considerably higher on a new car than the limit set in the rules. The wear of wheel tread, journal and brass and the wear of the beam hangers, and the eyes in which they swing, all tend to lower the brakes, and the set of the springs and sag of the car increase this tendency in brakes hung from the car body.

A new move in connection with the application of defect cards was the appointment of a committee to confer with pencil manufacturers and see whether an indelible pencil cannot be made which will be really indelible, and will avoid the present trouble in deciphering faded and washed-out cards.

Thursday.

On Thursday morning the reports of committees were again taken up. The able report of the committee on "Standards of the Association," which was presented but not acted on last year, was accepted, and the recommendations were ordered submitted to letter ballot, except where they were in conflict with the recommendations of other committees who had been investigating special standards during the year.

Axles, Journal Boxes, Lids and Wedges.—The committee, in its report, discussed the rescinding of the old standard for light axles, journal 3¾ × 7 ins., and concluded that as light axles were so nearly obsolete, new freight cars being nearly always built with the large axles with 4¼ × 8-in. journals, it was best, on the whole, to let the old standard die quietly without rescinding it or stirring up any discussion over it. Concerning journal boxes, lids, bearings and wedges, the recommendations were that corrected drawings should be published in place of those which are now in use. These drawings to be made full size and to be printed on strong transparent paper, so that blueprints can be taken from them direct. It was voted that the revised drawings be submitted to letter ballot for adoption by the Association.

Height of Drawbars and Standard Iron Brake Beam.—The committee on this subject received a very fair number of responses to its inquiries concerning a standard height of drawbar (the height to be measured from the top of rail to the center of drawbar when the car is new and empty. The reports received covered 519,897 cars, or almost exactly half the cars represented in the M. C. B. Association. The following table shows in condensed form the result of their inquiries:

Proposed standard height, in.	Cars now conforming to it, or which could be made to conform to it.		No. of cars which could not be made to conform to it.
	No.	Per cent.	
33	190,982	36.73	328,915
34	280,555	53.96	239,342
34½	270,375	52.00	249.5.2
35	413,567	79.55	106,330
35½	275,033	52.90	244,864
36	270,571	52.00	249,326

The committee believed that notwithstanding the fact that over half the cars in the country were not represented in the above, it might be taken as fairly representing the situation. They ventured no more positive recommendation, however, than the statement that it would probably be less hardship to the railway companies to go above the present M. C. B. standard (33 ins.) than to maintain it.

The second part of the task assigned to the committee was to revise the standard brake rigging to show "simply the center lines of a triangular brake beam with the Christie head and shoe in position, and the distance c. to c. of brake heads, location of brake beam strut, angle of brake lever, etc." The committee professed itself unable to carry out these instructions, chiefly on account of the great variation in the height at which brakebeams are hung, varying in cases within the committee's observation from 8½ ins. to 16 ins. on 33-in. wheels, measured from center of beam to top of rail. Until a standard height of beam is adopted for both inside and outside hung brakes, it will be impossible to adopt a standard angle for brake levers and location for brake-hanger eye.

No mention was made in the report of the fact that a standard height of drawbar is soon to be announced by the Interstate Commerce Commission, conformity to which will be compulsory by law; and considerable discussion followed as to what action it was best to take in view of this. Mr. Rhodes called attention to the fact that in one respect the report of this committee was misleading. The reports sent in, from which the statistics were compiled, gave in all probability the nominal height of couplers on cars, not their actual height, after years of service. The importance of close adherence to a standard height of drawbar with the M. C. B. coupler is very great. If it is considered that both lugs of the knuckles must be in contact, and that 1 in. bearing must be allowed on each lug, only 2½ ins. variation between the height of different cars is permissible. If, however, it is permissible to have only one lug of the knuckles in contact, then 4½ ins. variation in height is allowable. More than this, however, is not safe. He had seen cases where cars came apart without the knuckles unlocking, where there was only 5 ins. variation in height. Mr. Hennessy said that a drawbar 35 ins. high, when a car is new, would be down to 33 ins. after the car had run two years.

It was finally voted to report to the American Ry. Association and the Interstate Commerce Commission that the M. C. B. Association considers that 34½ ins. should be the standard height of drawbar for new, empty cars, and 31½ ins. should be the minimum height at which cars should be permitted to be run in conformity with the law. It was also voted that when the standard height was announced by the Interstate Commerce Commission, it should be submitted to letter ballot for adoption as a standard of the Association.

At a later session of the convention a reply was read from Colonel Haines, President of the American Railway Association, stating that the 34½ ins. fixed by that organization and reported to the Interstate Commerce Commission, was intended to be the standard height, and it was assumed that the Master Car Builders would make proper allowance on their shop drawings for the settlement of the car due to use.

With reference to the report on the iron brakebeam, it was voted to erase the drawing of the Westinghouse brakebeam from the standard drawings of the Association.

Tests of M. C. B. Couplers.—The report of this committee, which has been awaited with much interest, is given on another page. In accordance with the request of the committee they were continued for another year, and it was voted to make application to the Ordnance Department for the erection of a drop test machine for coupler tests at the Watertown Arsenal.

Cast Iron Wheels.—Messrs. Geo. W. West, W. H. Thomas and John Player, the committee on this topic, reported that they had received 25 replies in response to 300 circular letters requesting information as to the relative merits of wheels made in solid chills and those made in contracting chills. Of these 15 were from railway companies and 10 from wheel manufacturers. The following are the questions and answers and the comments of the committee:

Q. Have you ever practiced the manufacture of cast iron wheels from the same iron at the same time and in the same foundry in solid chills and in contracting chills? A. "Yes," 6; "No," 3; "No experience," 3; "Nothing to offer," 3.

Q. If yes, which chill did you find most advantageous in foundry practice? A. "Decidedly in favor of contracting chill," 5; "No data," 4; "Very little difference in favor of solid chill," 1; "No advantages in the contracting chill," 2.

Q. Have you had opportunities to compare the service of wheels made in solid chills with the service of wheels made in contracting chills? A. "Decidedly in favor of the contracting chill," 8; " "No records" or "No opportunities," 4.

Q. If yes, how does the service of the two compare as regards broken or cracked wheels? A. "Decidedly in favor of the contracting chill," 7; "No record," 1; "No advantages," 2.

Q. If yes, how does the service of the two compare as regards shelled out or soft places in the wheel treads? A. "Decidedly in favor of the contracting chill," 7; "No record," 1.

Q. If yes, how does the service of the two compare as regards sharp or soft flanges? A. "Decidedly in favor of the contracting chill," 9; "No record," 1.

Q. If yes, how does the percentage of flat wheels; which require to be replaced by the manufacturers compare as between wheels made in soft chills and contracting chills? A. "Decidedly in favor of the contracting chill," 7; "No record," 2.

Q. Have you noticed any less shelling out of wheels that were ground when new than when wheels were mounted without grinding? There was a uniformity of opinion that there were no advantages in grinding wheels.

Q. In general, can you call attention to any improve-

ment in the manufacture of cast iron wheels that has come to your notice that would be of advantage to wheel makers and users? The only improvement that any one had to offer was that of the contracting chill.

While representatives of three of our largest systems have failed to answer the question in detail, they have expressed themselves as decidedly in favor of the contracting chill, but for want of sufficient data have declined to answer questions.

From reliable data furnished by railroad companies and manufacturing companies which have kept accurate records, there appears to be a decided advantage in wheels made by the use of contracting chills. One of the largest roads in the country, which has been making wheels from the same iron at the same time in both chills, and which was in no way interested in any patents on contracting chills, says, that out of a total of 6,204 wheels, or 3,102 in each kind of chill, there was a percentage of loss of 5.35% in the solid chill as against 0.61% in the contracting chill. Another large manufacturer makes an almost similar report, and two of our most prominent master car builders are very emphatic in their statements of decided advantages in the uniformity of chill, true diameter, and freedom from soft places by using the contracting chill.

Following this report a resolution was passed tendering especial honor to D. H. Baker, M. C. B., of the Jersey City shops of the Pennsylvania R. R.. Mr. Baker was born in 1811, and has been in railroad service continuously since 1834. For 44 years he has been in the constant service of the Pennsylvania Railroad, or the corporations which preceded it, and has never lost a day from his regular service save to take a few weeks of vacation.

Steel Tired Wheels.—The following tables show the information collected by the committee, which consisted of Messrs. R. E. Marshall, J. O. Pattie and C. H. Cory:

Types of Wheel Centres Favored by Members.

Type of centre.		Preferred by No. of members.	Pass. cars represented.
Bolted		10	1,616
Solid Wrought	Spoke	2	578
	Disc	7	1,619
	No preference	4	3,548
Solid Cast		5	1,036
No preference expressed		7	1,964
Total replies		35	10,672

Objections to and Opinions on Spoke Wheels.

	Raising Dust.	Noise.	Hard to clean.	Run springing.	Various reasons.	Total objections.	No objections.	No opinion expressed.	Total replies.
Members	11	1	2	1	1	16	12	7	35
Pass. cars represented	1,689	73	600	332	485	3,179	2,300	5,193	10,672

Weights and Prices of Principal Steel-Tired Wheels.*

Manufacturers or Agents.	Name of Wheel.	Weight. Lbs.	Price.
Bolted Centres:			
Allen Paper Car Wheel Co.	Paper Center No. 1	775	$52.00
Brooks Locomotive W'ks	Thurber	796	57.50
Cast Centers—Plate:			
Allen Paper Car Wheel Co.	C. I. Dbl. Plate Spoke, No. 9	775	47.00
	C. I. Dbl. Plate Spoke, No. 11	775	50.00
	Cloud Boltless	775	47.00
A. Whitney & Son		850 to 900	45.00
Ramapo Wh'l and Found'y Co.	Snow Boltless	912	48.00
McKee, Fuller & Co.			
Taylor Iron and Steel Co.		785	37.00
Cast Centers—Spoke:			
Allen Paper Car Wheel Co.	C. I. Spoke No. 7	775	47.00
	Cloud Boltless	775	47.00
A. Whitney & Son		850 to 900	45.00
Ramapo Wh'l and Found'y Co.	Cast Spoke	912	48.00
McKee, Fuller & Co.			
Taylor Iron and Steel Co.		785	37.00
Wrought Centers—Disk:			
Page, Newell & Co.	Brunswick	670	48.00
Thos. Prosser & Son	Krupp No. 1	800	57.00
Boies Steel Wheel Co.	Boies, W. L., Centre No. 2	800	48.00
Chas. G. Eckstein & Co.	Arbel	675 to 725	44.00 to 46.00
Wrought Centers—Spoke:			
Page, Newell & Co.	Brunswick	670	48.00
Chas. G. Eckstein & Co.	Arbel	675 to 725	44.00 to 46.00
Standard Steel Works	Vauclain	680 to 700	45.00
Philip S. Justice & Co.	Owen & Dyson	725	45.00
Steel Truss Car Wheel Co.	Steel Truss Wheel	700	50.00

* Prices given above are all for 33-in. wheels with 2½-in. tires, except the Thurber wheel, made by the Brooks Locomotive Works, which has a 2¼-in. tire.

This report was followed by one of the most interesting discussions of the convention. Mr. Bissell, of the Wagner Car Co., objected that the facts most desired as to the durability and safety of the different wheels were not shown by the report. Mr. Marshall said that the committee attempted to get this information for the report of the previous year's convention, but found it impossible to do so. Mr. Adams said the percentage of breakage of the different wheels, their mileage and the tires used to produce the mileage were facts which should be of much interest. Mr. Rhodes said that while there is a very general impression that a steel-tired wheel is the only safe wheel, his experience and experiments did not prove that the steel-tired wheels were the safest and best. It is well known that in machinery steel running on steel does not wear well, and brake shoes are made of steel especially to wear down tires. There is considerable evidence to show that steel-tired wheels are responsible for a good deal of excessive rail wear and flange wear. On a certain road with sharp curves, where rails on curves formerly lasted five years, they now have to be removed in two years. The traffic has increased somewhat in that time, but there has been a specially large increase in the use of steel-tired wheels. Some lines in the West have tried steel-tired wheels on engine trucks and tender trucks, and have had to go back to cast iron wheels because of the rail wear. It is a fact that the Palace car companies have had to alter the diameter of their wheels because of the heavy flange wear. He had thought that wrought centers for steel-tired wheels would be practically indestructible, but his experience had been that such centers did break, apparently quite as frequently as the cast centers. As the wrought center costs about $45 and the cast center only $9, the former should have some marked advantage or it is not worth while to use it.

Mr. Bissell said that where he had used the flange brakeshoe with the steel wheel he had never had wheels come in with sharp flanges liable to shear the edge of the rail. As to safety, he agreed with Mr. Rhodes that the superiority of the steel-tired wheel to the cast-iron wheel was yet to be proved. He had recently had a tire break on a new wheel which had not been in service a week. Mr. A. M. Waitt thought the design of the center had very much to do with the safety and durability of the wheel. The cause of broken tires was often to be found, not in the tire, but in the center. He had wheel after wheel removed because of bolts loose or bolts partly sheared, or for tires loose and revolving on the center. The paper center is liable to injury by the heat due to the use of brakes. On the other hand, he knew of a road which had 14,000 steel-tired wheels in service eight years without a single failure. The tires were the same as those used by the Lake Shore, but the centers were different.

Mr. Adams said that in the Boston & Albany's long experience with steel-tired wheels no serious accident had ever been caused by their failure. If there is a defect in a steel-tired wheel proper inspection will discover it before fracture occurs. Where the tire was bolted to the center the bolts were liable to be sheared when the tire was heated by the brakes and loosened on the center. A tire welded to the center will not do this; or if it can turn freely on the center no harm will result. Respecting the relative cost, the Boston & Albany officers have determined that where a car makes 200 miles or over per day the steel-tired wheel is much cheaper than the cast-iron wheel. On the other hand, where a car makes only a small mileage, the interest on the greater first cost of the steel-tired wheel makes it the more expensive. Mr. West said that, as showing the importance of well designed centers, the New York, Ontario & Western has at present 75 steel-tired wheels at its Middletown shops. Of these 73 were removed for defects of centers and two only were removed for tire failure.

On motion of D. L. Barnes, the subject was referred back to the committee with instructions to investigate the subject further and include in its report the number of parts, weight of center, weight of tire, method of fastening tire, process of re-tiring and liability of tire or separate parts to loosen, and safe limit of wear of tire for all steel-tired wheels in use.

Friday.

Protection of Trainmen and Lettering Fast Freight Line Cars.—The report of the committee on this subject, as first presented, was not satisfactory, and it was referred back to them for consideration. Their amended report was taken up on Friday morning. In substance, it was that the list and dimensions of appliances designed for the safety of trainmen should be transferred from the list of standards of the Association to the proposed new head of "recommended practice." The changes made were chiefly in the simplifying of the rules, except that hand-holds were required on the ends of flat and gondola cars, to conform to the safety appliance law. The lettering of fast freight line cars was also recommended for transfer to "recommended practice," and the rule was amended to require the lettering of side doors with name of the line and the car number. The question was brought up whether the uncoupling rod on a car with M. C. B. coupler might not be utilized as a hand-hold by recessing the sill behind it. It was explained that this as in fact, all the appliances for the safety of trainmen, was to be optional with the members, except as provided in the Interchange Rules.

Tests of Brakeshoes.—The special committee appointed at the first day's session to determine the feasibility of an extended series of shop and road tests of brakeshoes reported that such tests were perfectly feasible, and could be made at a moderate expense. They advised that a committee of not less than 12 members from as many different roads be appointed to make the road tests, beginning as soon as possible, the work to be done under direction of a head committee of three members. For the shop tests, it was suggested that arrangements could probably be made with the laboratory of Purdue University, or with some of the exhibitors at the World's Fair. An appropriation of not more than $500 in the Executive Committee's discretion was named as a proper sum. The committee's recommendations were adopted without dissent, and a dozen roads immediately volunteered to undertake part of the road tests.

Freight Car Truck Frames.—This report, made by Messrs. J. C. Barber (No. Pac.), W. S. Morris (Ches. & Ohio) and L. A. Crone (N. Y. C. & H. R. R.), was one of the most extended of any presented to the convention. We reprint it separately on another page. The only discussion was by Mr. R. C. P. Sanderson, of the Norfolk & Western. He said that his experience with pressed steel center plates had not been satisfactory. Under the continual hammering of service the pressed steel plate turns up the edges. It then begins to move on the bolster and soon saws off the bolts. With certain designs of compound bolster the wood is made in three pieces, and while it is strong enough vertically, it has very little lateral strength. Thus, when a car runs against a bumping post or gets a heavy blow in switching the bolster is liable to be bent forward or backward. The folly of expecting strength and stiffness from wood and iron in combination is apparent when it is remembered that green oak will shrink from ⅜ in. to ½ in. per foot in drying. Car inspectors are not numerous enough to keep bolts screwed up as the wood shrinks. The spring cotter for fastening nuts should be made with a taper like a key, and the slot in the bolt should be long enough to admit of some variation in the position of the nut on the bolt and still permit close locking by the cotter.

With reference to arch bar breakages, their cause appears to be not that the arch bars are not made of heavy enough metal, but that they are not bent properly to fit the column castings. Also in the case of the bottom tie-bar the holes in it are punched and the thread on the column bolts is cut so far up that the thread bears against the hole in the tie-bar. A poor fit is then inevitable.

Tests of Air Brakes.—The greater part of the report of the committee on this subject was devoted to a description of the brake-testing plant at Altoona, Pa., erected for the use of the Association by the Pennsylvania R. R., and formally turned over to the committee on May, 1893. Briefly described, the plant consists of a substantial frame building 40 × 30 ft., containing a brake testing rack equipped with 100 sets of brakes and room for a rack of equal size on the other size of the building. The rack now in place has one set of 50 Westinghouse quick-acting brakes complete, and one set of 50 without the triple valves, the design being to place the triple valves to be tested on this rack. The piping is the standard for 34-ft. freight cars, fitted up in practically every way as in service, and the two sets of 50 brakes are so connected that the same trainpipe is used for each, a 3-way cock on each brake connecting either the upper or lower triple valve, as desired. Thus, in testing triples, the same trainpipe is used with the set to be tested that is used with the standard. Each set of 50 brakes has engine and tender brakes and piping of standard sizes and lengths and arranged as

nearly as possible in the same manner as on a consolidation locomotive.

As recommended in the last year's report, each cylinder is fitted with a device for limiting the stroke of the piston, by which strokes of 4 ins., 6 ins., or the full stroke of 12 ins., may be made. An electric chronograph is arranged to make an automatic record of the movement of the engineer's valve, the movement of the 25th and 5th pistons, and the attainment of 55 lbs. pressure on the 50th piston.

The "standard of efficiency for all brakes" reported to the Association last year was intended only as a preliminary outline to be worked over and improved upon as experience may suggest, and the committee made no further recommendations as to tests, merely suggesting that in view of the large and complete test racks erected by four brake companies at the Chicago Exposition action should be delayed until the results of tests to be carried out on these racks shall be made public. The committee, therefore, asked to be continued, promising its final report at the convention of 1894. The concluding part of the report was devoted to an interesting statement of the results of an examination of the condition of screens in triple valves and drain cups, which we shall print later. After hearing the report the Association passed a vote of thanks to the Pennsylvania R. R., and voted to print separately that portion of the report relating to the condition of drain cups and triple screens for distribution to the car inspectors of the several roads.

The next report presented was that on "Steel Center Sills for Freight Cars." We reprint it separately elsewhere. The committee on "Steam Heating for Passenger Cars" was called for, but it had no report ready. The committee intrusted with revision of the schedule of labor charges in the interchange rules was called for, and presented a report changing somewhat the prices on refrigerator repairs and adding prices for cars fitted with three and four intermediate sills. The committee on subjects for the next convention reported a list, including the following: A standard for iron brakebeams, as recommended by the committee; a standard location and arrangement of safety chains; passenger car heating, ventilating and lighting; handbrake gear on freight and passenger cars; wheel gages; compressed air and its use in car shops, and car lubrication.

The committee appointed to consider the new location for the dummy coupling for air brake hose, advocated by Mr. A. M. Waitt and adopted on the Pittsburg & Lake Erie and the Lake Shore & Michigan Southern, reported that it was preferable to the present standard, and advised that it be submitted to letter ballot for adoption in its place. By the old standard the dummy coupling is placed 15 ins. from the end of the brake pipe toward the side of the cars. The proposed new standard places it on the under side of the drawbar carrier iron and on the opposite side of the center, so that the hose hangs in a loop under the coupler. The advantages are that the hose hangs in an easier curve, and is not kinked. The drawbar protects it from injury by lumps of coal or ore falling from the car, and it cannot be used as a step by the brakemen. Further, in coupling up, both couplings can be reached by a trainman without crossing to the other side of the car.

It was then voted that the present size of the printed annual report, 6 × 9 ins., be made a standard, and Messrs. G. W. Rhodes, R. C. P. Sanderson and W. H. Lewis were appointed a committee to confer with manufacturers of railway supplies and induce them to adopt that size as a standard for all trade catalogues. The convention then adjourned.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The twelfth annual meeting of the Association was held at Worcester, June 14 to 16, inclusive.

A large part of the opening address of President Chace was devoted to the qualifications of water-works superintendents, he first stating that the smaller the town the smaller the salary and the more diverse the duties of the superintendent. In brief, the superintendent should be self-reliant, but not self-conceited; able to size up a man; the more he knows of civil and mechanical engineering the better it is for all concerned, but he must above all have a thorough understanding of water in all its phases. The superintendent should be a reading man, a practical man, and a gentleman, and in order not to be behind his profession he should belong to the association or associations connected with it.

The executive committee reported a net gain of 47 members during the year, making a total of 412 members, of which 338 were active, 5 honorary and 69 associate. The growth of the Association was shown by the following figures, which give the membership at the beginning of each Association year:

Year.	Members.	Yearly increase.	Year.	Members.	Yearly increase.
1882.....	27	..	1888.....	258	47
1883.....	43	16	1889.....	277	39
1884.....	57	14	1890.....	335	58
1885.....	127	70	1891.....	360	25
1886.....	153	26	1892.....	365	5
1887.....	191	38	1893.....	412	47

The report of the committee showed total receipts of $3,334, collected by the secretary, and $190 of interest, which, with last year's balance, made a total of $5,331. The total expenditures for the year were $3,317, leaving on hand $2,014.

Mr. Desmond FitzGerald, M. Am. Soc. C. E., as chairman of a committee on uniformity in preparing annual reports, referred to the standard form adopted some eight years ago in accordance with the recommendation of Messrs. Coggeshall and Billings, and expressed the belief that the form could not be improved. Eighteen cities have adopted the form. It was recommended that a large edition of the original report on this subject be printed for distribution, and the matter was referred to the executive committee, with power. Mr. Dexter Brackett, M. Am. Soc. C. E., urged that more places adopt the report.

A paper was then read by Mr. John Thompson, M. Am. Soc. C. E., entitled "Is the Game Worth the Candle?" This proved to be neither a discussion of game or candles, strictly speaking, but a very excellent paper dealing with some of the practical and economical questions connected with meters. An abstract of this paper appears elsewhere in this issue.

In discussing the paper, Mr. Walker inquired about the effect of tank service upon the meters designed for only approximate accuracy for use on small services, with a view to cheaper construction and maintenance. Mr. Walker thought the consumer would fill his tank very slowly, and thus get more than his money's worth through lack of registration. Mr. Thompson replied that for tank service the greatest possible sensibility of the meter was required.

Mr. Brackett agreed largely with the ideas expressed in the paper. He also referred to the use of service tanks as a cause of trouble in connection with meters, and the present tendency to make the use of tanks obligatory in large cities. In regard to the small proportion of taps metered, stated as being only 6 or 7% a year or two ago, Mr. Brackett said that the percentage of water consumed was the real test, not the percentage of taps metered. In Boston, while it is true that only about 7% of the taps are metered, some 27% of the water consumed passes through meters. More water passes through the 140 meters in use at New Bedford than the 4,000 at Fall River.

The man who doesn't believe in meters under any consideration was not present, the Association having either educated most of these or else frightened or shamed them into silence. Mr. Walker, however, believed that the minimum meter rate of $12, as charged at Manchester, N. H., was so small that it did not pay to buy and maintain meters, which the city does. Where water was scarce, it might be different.

Before the afternoon session adjourned Mr. Nevons stated that having been unable to find calipers for gaging the thickness of new cast iron pipe he had devised a pair, which he described with the aid of a photograph. A view of these calipers is given herewith. They are of forged steel, about 6 ft. long, fitted at the

Callipers for Cast-Iron Pipe.

middle with a thumb-screw. The lower leg is inserted in the pipe and the bail brought up to its inner surface. The pin at the end of the upper leg plays up and down, and is provided with a scale, from which the thickness of the pipe can be read.

On Wednesday evening, a new and interesting subject for consideration at a water-works convention, or, if not a new subject, an old one with a new form of treatment, was that assigned to Mr. W. E. McClintock, M. Am. Soc. C. E., who on Wednesday evening read a paper on "Water Pipe Trenches Versus Good Roads," and followed its reading with a large number of stereopticon views.

Mr. McClintock stated that water, gas, sewerage and street railway systems are destructive of good roads, but since for all of these the civil engineer is employed it lies with him to see that this destruction be as little as possible. The whole matter really hinges on the disposition of the material during trenching for mains and the back-filling which follows pipelaying. In trenching, the upper few inches of the roadway should be placed at one side and the remainder on the other side of the trench. The excavated material can then be returned in its proper order. By placing the excavated stone near the surface of the street and carefully covering them a drain is virtually formed, and a road may thus be improved.

The following figures for shrinkage of different kinds of material in trenches were cited as from a good authority: Gravel, 8%; gravel and sand, 9%; clay, 10%; loam, 12%; puddled clay, 25%.

By experiment Mr. McClintock found that in back-filling a trench 1½ ft. deep in clayey loam and ramming in layers not over 3 ins. thick there was a 11% shrinkage. In actual practice in connection with the construction of 8 to 12-in. sewers in Belmont, Mass., the roadway was restored in accordance with his specifications to an even surface, ramming being employed. Further experiments and observations had led Mr. McClintock to advise thorough ramming in connection with all back-filling, "using water on clay or hard-pan and no water on sand, gravel or sandy loam. Any amount of ramming will affect only a comparatively thin layer."

Regarding the possible objection that efforts to maintain the roads in good condition is no part of the business of a water-works superintendent, the author stated that it is the business of such a man to leave things in as good a shape as found. The additional cost of good work in this direction is comparatively small.

The stereopticon views shown by Mr. McClintock were first of the fine telford-macadam roads in Franklin Park, Boston, and views at intervals along some 900 miles of Massachusetts roads, from photographs taken for the Massachusetts State Highway Commission, of which Mr. McClintock is a member; these were followed by several views of roads badly injured by water trenches. Most of the views outside of Franklin Park showed very poor roads, but it was stated that the commission believed that good roads can be secured in the state.

Mr. Fuller agreed with Mr. McClintock to a great extent, but said that he found it difficult to get contractors to restore the roads with the necessary care, probably because of the low prices at which the work is done.

Mr. Nevons said that in Cambridge about 1 ft. of earth is thrown into the trench, then the trench filled about half full of water, and so on, ramming being employed at the top. This gave excellent results, even with a 30-in. main recently laid. He believed in leaving the roads in first-class shape, but wanted water every time as an aid.

Mr. Decker stated that he believed in using water; also that in a 4½-ft. trench in a Kansas town he had to borrow 6 ins. for back-filling after laying a 12-in. main, and that he believed the trench did not settle an inch.

Mr. French said that he used water as an aid in back-filling when he could get it, but that it could not always be obtained; for instance, the Hackensack Water Co. laid 10 or 12 miles of mains in Englewod, N. J., last fall, and could not get water. Much complaint of settling and necessary repairs followed. He did not state whether ramming was employed.

The evening session closed with an interesting paper on the "Laboratory of the Massachusetts Institute of Technology," by Prof. Dwight Porter, this paper also being illustrated by stereopticon views. The views showed the interior of the laboratory, a plan of the pipe arrangement of the second floor and various apparatus in detail; also some diagrams giving the results of hydraulic experiments and stream gagings. The substance of this paper is given in another column with considerable information in addition regarding the hydraulic courses of the Institute, and with reproductions of the originals of some of the views. At the conclusion of this paper, President Chace remarked that he had heard a man say in this connection that he was born too soon, his education having been received before the days of such aids to engineering studies.

Thursday Morning.—The first business of the meeting was the election of the following officers: President, Geo. E. Batchelder; Vice-Presidents, J. S. Maxcy, Chas. Walker, F. H. Crandall, Geo. A. Stacy, Byron I. Cook, Sherman E. Grannis; Secretary, R. C. P. Coggeshall; Treasurer, Hiram Nevons; Senior Editor, Dexter Brackett; Junior Editor, Walter H. Richards; Executive Committee, F. F. Forbes, A. F. Salisbury, P. Kieran; Finance Committee, John C. Whitney, John L. Harrington, F. W. Sawyer.

The selection of a place for the next annual meeting was referred to the executive committee, with power.

The first paper of the morning, "An Experience with a Stand-Pipe," was then read by Mr. John C. Chase, M. Am. Soc. C. E. An abstract of his paper appears elsewhere in this issue.

Mr. Fuller inquired whether the two layers of plank mentioned in the paper were laid at right angles to each other. Mr. Chase replied that he wished to lay them so, but for fear the sides of the stand-pipe would not bear the strain the two layers were parallel, with broken joints.

In the absence of the author, Secretary Coggeshall read a paper prepared by Mr. Wm. R. Hill, M. Am. Soc. C. E., entitled "The Location, Construction and Laying of a 54-in. Steel Submerged Pipe in Skaneateles Lake for the Syracuse Water-Works." The pipe was about 6,400 ft. long. This paper appeared in our issue of June 15. A description of a large steel pipe, this one being 48 ins. in diameter and 21 miles long, with a branch 36 ins. in diameter and five miles in length, was included in an exhaustive paper on "The Works of the East Jersey Water Co. for the supply of Newark N. J.," by Mr. Clemens Herschel, M. Am. Soc. C. E. An abstract of this paper was begun in our issue of June 15.

(Continued on page 595.)

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York. Entered at the Post Office, New York City, as Second Class Matter

VOL. XXIX. THURSDAY, JUNE 22, 1893.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

Chicago Office: Monadnock Building.
F. A. PECKHAM.....MANAGER

EUROPEAN AGENCIES.
KEGAN PAUL, TRENCH, TRUBNER & Co. (Limited), Paternoster House, Charing Cross Road, London, Eng.
SAMPSON LOW, MARSTON & Co. (Limited). St. Dunstan's House, Fetter Lane, London, Eng.

SUBSCRIPTION RATES: One year, $5.00; 6 months, $2.50; 4 months, $2.00; single copies 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. They should send both the old and the new addresses. No club rates are allowed.

The date when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance. No other receipt is sent unless requested.

ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last paper go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

In discussing the Lafayette accident in our last issue we called attention to the fact that the average trainman seldom or never opens the conductor's valve to apply the brakes, and consequently is entirely unfamiliar with its use. The consequence is, first, that when an emergency comes he is as liable to do the wrong thing as the right; and, second, that the valve, or more properly cock, is somewhat liable to be stuck fast, and to require so much force to open it as to very easily deceive the trainman into the belief that he is pushing the wrong way when he is in fact all right. The Superintendent of Motive Power of one prominent Western road informs us that some years ago he foresaw and guarded against the dangers due to the infrequent use of the conductor's valve by educating his passenger trainmen in its use. On his road the conductor's valve is in regular daily use in stopping trains. In fact it takes the place largely of the air signal, which has never been adopted there. If a train starts too soon from a station, the conductor stops it, not by signaling the engineer, but by opening the conductor's valve. So, if the conductor wishes to stop the train to let off a passenger where a stop is not scheduled, he pulls the valve. Thus, the daily practice of the trainmen is such as to lead them from force of habit to rush immediately to the valve when they wish to stop the train. Of course, with constant daily use the valve is kept in good order and an emergency does not find it wanting.

To avoid danger of breaking the train in two, the engineer has instructions to always close the throttle whenever he feels the brakes applied. Signals are given by the bellrope on trains of moderate length, but on the through express trains the bellrope does not run through the sleepers. Instead of a bell a whistle is used in the cab. The trouble with the old style of bell was that the spring had not sufficient power to pull the hammer back on long trains and the conductor's repeated pulls would produce no effect. In place of the bell a small shrill whistle is used, and if the spring does not retract it when the rope is slack between the signals its continual sounding warns the engineer to reach up and pull it back.

It may be objected to the plan of stopping trains by the conductor's valve that it is likely to operate the quick action and stop the train with a jerk. But we are informed that with care not to let out too much air, the service application can be made with the conductor's valve without difficulty. That the system has its benefits as a safeguard is well shown by the experience at Lafayette. It is a rule that has few exceptions that for a safety device to be really a safeguard frequent use is essential.

There has been considerable agitation lately in the direction of another deep-water entrance to the Mississippi River, and complaints have been frequently made that vessels of heavy draft ground in the Passes and encounter much trouble in getting to sea. The "Times-Democrat," of New Orleans, in commenting editorially upon these complaints, admits the facts, but says that the conditions causing them are merely temporary and liable to occur at this season of the year. It has been shown by the surveys that the full depth of water has been maintained through the jetties called for in the contract with the United States government. But the shoaling reported results from causes other than those directly connected with the jetties and the dredging between them. Few except those very familiar with the Mississippi River have any idea of the volume of sediment carried by it from the muddy Missouri to the sea. The rises in this latter river are chiefly responsible for the mischief done and it deposits its mud wherever the river broadens out and the current is thus reduced in velocity. The mud lumps or shoals thus formed shift from week to week with changing winds and currents, and are more troublesome than usual when the Mississippi is swollen, as it is at present. The improvement in the levee system increases the difficulty by preventing the river from overflowing its banks and depositing much of its sediment in the swamps and low lands alongside. The river is now better confined than in years past, and consequently the bulk of the sedimentary matter passes on to the Gulf. But when the river goes down its mouth returns to its normal state and the current keeps the channel open. But the fact remains, that any serious accident to the one existing outlet to the sea, such as the grounding or sinking of a vessel there, would bottle up the commerce of the river effectually. This danger is always imminent and the improvement of the Southwest Pass is an imperative necessity, says our contemporary. Mr. Eads has solved the problem of method best adapted to that particular situation, and the channel provided by him has so encouraged commerce that it is little wonder that those interested are urging the necessity of the second channel upon our national legislature. One outlet for interests as vast as those involved, and that outlet liable to blockade, is evidently not enough.

The city of Duluth voted on May 31, by a majority so large as to make the ballot almost unanimous, not to grant the subsidy asked for by the promoters of a great water power scheme at that city. The particulars were given more fully in our issue of June 8. It is sufficient to say here that the subsidy asked for was $600,000 in 4% bonds, necessitating an addition to the annual taxes of $24,000 to pay interest alone, besides the necessary yearly contributions to a sinking fund to meet the bonds when due. The action of the city is noteworthy because Duluth and other cities of the West and Northwest, have never been noted for financial conservatism. All these cities whose phenomenally rapid growth during the past score of years has been a source of wonder have boomed themselves by granting heavy subsidies to railways, manufacturing enterprises, electric plants, and in fact about every sort of industry whose promotion would enhance the price of real estate. There is much to be said both for and against this policy. The greater cities like Chicago, Kansas City, Minneapolis and Duluth itself have gained, on the whole, perhaps, more than they have lost in the granting of subsidies. But the smaller cities and towns have many of them saddled themselves with burdens of debt and reaped little or no benefit in return. But whatever the question as to the wisdom of granting the subsidies which were given in the past, it must be conceded that new and different conditions are now prevalent; and even though Duluth and Chicago were the gainers by the money they subscribed in aid of railway schemes a score or a dozen years ago, it does not follow that the granting of subsidies is to-day a wise policy. As the cities of the Northwest increase in wealth and prosperity, it is inevitable that they should become more conservative. No one would dream of asking from an Eastern city a gift of $600,000, no matter what important enterprise it was proposed to carry through. A man or a city can afford to "mortgage the future" when the property mortgaged has only small value and depends for a prospective large increase only on the success of the scheme to aid which the mortgage is given. But when either a man or a city becomes wealthy, heavy burdens of debt will not be assumed unless the benefits to be attained thereby are worth all they cost.

Taking this water power enterprise in Duluth as an example, it is only the part of wisdom for the city to inquire whether the enterprise would not be carried through in any event without the city's aid. If all is true that is stated by the promoters of the enterprise, capital will not long be wanting to carry through so profitable a work. Every one assents to the proposition that a city should conduct its affairs on business principles. But what wealthy business man would borrow money to present as a gift to a corporation having a scheme to benefit his lands? Instead, he would thoroughly investigate the enterprise; and if he satisfied himself that it is sound and well planned, but that his financial backing was necessary to place it on its feet, he would subscribe to the company's first mortgage bonds, such an amount as was necessary to secure its success. A city ought not to engage in risky speculations nor to be less careful how it lends it credit than is the average conservative business man.

It is easy to force a city's growth and fill it with an apparent prosperity for years by ignoring these things and pushing development with the reckless boomer's methods which have prevailed in so many Western towns. But the day of reckoning comes at last; Sioux City, for example, is paying the penalty now for her forced prosperity of a few years past. Her citizens are finding that it is sometimes better to make haste slowly. For all these reasons, therefore, the action of Duluth in the matter must be considered as a most hopeful sign, and an indication that an era of greater conservatism and more permanent prosperity is at hand in the West. For many years to come the liberal spirit and the universal devotion to local interests will continue to characterize the cities of the West. But promoters of new enterprises should learn a lesson from the experience of the Minnesota Canal Co., at Duluth; and when they ask municipal aid for their enterprises they should ask only what can be justly and wisely given.

THE BOSTON SUBWAY BILL.

A measure of no common interest and importance became law in Boston on the 10th inst., which bids fair to place Boston in the van of progress on the rapid transit issue. In its substance the bill provides for the construction of a four-track subway for electric street cars through the crowded part of Tremont St. substantially on the plans advocated by this journal in its issues of March 16 and 23, 1893, and also for extending it through Court St., and if the subway be wisely constructed and managed, as it seems likely to be, the result in our judgment will be to give an immense impetus to the construction of such works on a much larger scale in Boston and many others of our larger cities, with the result of greatly simplifying the problem of rapid city transit without defacement of the streets.

The bill provides that the Mayor and Aldermen shall appoint a Board of three Subway Commissioners, who shall be authorized to lay out a subway for "two or more" (meaning four) tracks through the crowded part of Tremont St., and for extending it also through Court St., "or other streets and lands" to such point or points as they deem best. The Board is granted full powers to employ one or more engineers and a competent architect "to prepare plans for the architectural features and details, which shall be made architecturally and otherwise as attractive as may be within reasonable limits of expense."

To provide funds the city of Boston (which means its elected representatives) "may" issue $2,000,000 of 4% 50-year bonds as needed, which under the conditions at Boston should be enough to provide liberally for extending the subway through both Tremont and Court Sts. After the subway is built the Board may compel any street cars now using the surface to use this subway at rates which

they determine to be "just and reasonable," which doubtless means at rates which will pay to the city the annual interest charge. This, it is understood, the West End Railway Co. will very cheerfully do, they feeling favorable to the project, as they well may, since it could hardly fail to result in a direct gaining to them of nearly the full interest charge, in addition to the stimulating effect on travel which is quite certain to result. The commissioners are also given power to utilize the subway for the pipes, wires or conduits of private companies at reasonable rates, but may not compel them to use the conduit. The act takes effect immediately.

It will be seen from this summary that the bill is permissive, not mandatory; but there is not felt to be any reasonable doubt, we believe, that the act will go at once into effect to the extent of organizing the commission and preparing detail plans for the subway. The city appears to have discretion under the act either to authorize this expenditure first and the rest afterward by any number of successive appropriations, or to authorize the whole expenditure at once, and will naturally be more apt to adopt the tentative policy.

The passage of this bill was followed the next day by the passage of a much more stringent permissive bill for submitting a project for an elevated railway to the people, after some corporation has undertaken to build and operate the road if the city provided the right of way; but this bill is loaded down with so many necessary stipulations as to consequential damages and the like that it seems to us unlikely even to reach the stage of a popular vote, still less to pass it.

Boston, therefore, bids fair to take the lead of all our cities in the study and construction of a rational type of subway for electric city transit, in which the subway is used as far as there is real necessity for it, and thereafter the surface. It will make this experiment under peculiarly favorable constructive conditions in many ways, and therefore it can hardly fail to secure such successful results that the example will be promptly followed by many other cities with a corresponding gain. It is so desirable that this should be so, so far as depends on the selection of right details, that we depart from the usual practice to consider somewhat in detail what the main characteristics of such a work should be. It is really, as we see it, a question of great and general public importance that no mistakes should be made in this first experiment, such as were made in the London underground lines, for example, tending to throw a cloud upon the rapid extension of such enterprises, which otherwise is sure to come.

Certain great advantages a subway has from its very nature, and cannot be deprived of by any cool in summer, dry in wet weather, calm in windy weather, safe to the foot in slippery weather. These are no small gains, but there are two still more important ones in which it is naturally defective, and as to which art must help out nature. The first of these is sufficient light, a bright and cheerful appearance; the second perfect ventilation.

To the first end the subway should be brilliantly lighted, and every particle of its interior, excepting limited decorations and the railtops, should be pure white as nearly as may be, roof, roadbed, walls and columns. This done, a very moderate number of electric lights will make the subway to all intents and purposes as light as day. As electricity is used for power the cost of perfect lighting will be still farther reduced, and the cost of using enough light to enable a newspaper to be read in any part of every car as easily as on the surface, even without using lights in the cars by day, will not be a sensible burden. These white surfaces once secured there is nothing to soil them. They may therefore be secured by paint alone sufficiently well, except as to the roadbed, but they may be still better secured at no serious cost by making the shining faces of all masonry walls of white tile or porcelain-faced brick.

The ventilation problem might possibly be left without serious objection to take care of itself through a sufficient number of openings, since neither animals nor steam are to be used in the subway; but to avoid all mustiness, and also to prevent too great differences of temperature between the subway and the outside air, electric suction fans of some power should, perhaps, be placed near the middle of the tunnel, drawing in air from each end; and in this case the frequent entrances into the tunnel might also need, perhaps, to be closed by swinging doors, though more probably these would not be necessary, especially if several small ventilating fans were used at scattered points instead of large fans at one point. Passable results as to ventilation may be secured with hardly any trouble, and might prove to be more than passable; but to secure the best results at least cost, careful study of this detail will be demanded.

These two details alone, properly studied on the lines outlined, would insure that the subway when once entered would be a cheerful and attractive place, but there are still two other ends which may not be neglected with impunity: (1) That the subway shall be easy of access, and (2) that it shall be safe to foot-passengers.

To secure the first end, every additional foot of depth below the surface should be grudgingly conceded to necessity alone. Precisely what interior height should be conceded, or what thickness of street surface, we are not at present prepared even to suggest; but the roof or street surface should be made as thin as is consistent with necessary strength, by the free use of columns below and by the use of asphalt or wood surfacing which does not need the thickness of stone above the concrete foundation which would naturally be used. Boston as yet knows very little, from experience, of either of these pavements, but as London will use nothing else on its most crowded streets it is probable that they are good enough for Boston also, at least where there is special reason for using them.

Similarly, it would be absurd to compel a whole city, for all time to come, to go up and down two or three feet more of stairs than was otherwise necessary in order to enable the present style of trolley to be used. It would involve no serious difficulty nor expense so to modify this detail that not more than two or three inches clearance above the highest cars now in use would be needed for this use, and no more should be conceded to it. We are not prepared to discuss now just how this should be done, but it is obvious that it can and should be done. The cars themselves are also fully as high now as public comfort demands, and no provision should be made for any further increase. Fortunately for subway projects, the prevalent European custom of carrying more passengers on top of the car than inside of it has never taken root here, and in our climate of extremes is not likely to.

The problem of convenient access is likely to make more trouble than any other, and yet, rightly handled, we see no reason why any serious difficulty should result from it. The ideal subway for electric street cars, both for the public and the abutting owners, should have a sidewalk on each side of the line with shop-fronts to each building opening on it. These would soon become almost or quite as valuable as the main street front, and they would also afford access at every point to the subway. With occasional sub-footways under the tracks to enable passengers to cross safely from side to side, this would completely solve the problem of access.

But the difficulty about this otherwise perfect solution is that the greed of the abutting landowners will lead them to demand damages for being thus benefited, or at least to demand that the work of shoring up and underpinning their buildings so as to give them this additional shop front in an effective way should be borne by the city. Because of this pitiful weakness of human nature, which would be sure to increase largely the cost of the work, this feature of it should, in our judgment, be abandoned, except to the extent that the abutting owners are shrewd enough to see their own interest and to provide for it without extra expense to the city, as nearly all of them would do when the alternative was placed sharply before them of having a solid wall under their curb line and keeping their coal cellar, or getting the same wall built on their building line and getting a new rentable first floor. There will be an outcry at this—an effort to make the city pay a price for the chance to do them a favor; but in Boston, at least, we hope there is still public virtue enough to resist such pressure. And, what is more, an abutting owner should not be permitted to play a game of bluff beyond a certain date, but thereafter should have the privilege of getting a new shop front on the subway only on payment of a certain sum for the privilege. A very considerable portion of the length of this subway, however, will on one side or the other be under land belonging to the city, and there the subway sidewalk should be made continuous. It is really in no way essential to the main purpose of the subway that there should be a complete sidewalk, or any sidewalk, on either side of the subway.

The architectural opportunities of such a subway would be great. No architectural feature is more effective and impressive than long and well handled vistas of columns. By proper groupings of the lights, by relieving the general whiteness with well chosen decorations, by slightly deviating from the street lines and grades so as to secure more perfect alinement below, a little architectural knowledge added to ordinary good taste will secure very fine effects. At the termini of the subway it will be necessary to buy a little land to provide for entrance and exit without unduly contracting the street, but otherwise this great improvement can be carried through without either condemning or injuring any private property.

BREAKAGES OF M. C. B. COUPLERS.

The percentage of breakages of M. C. B. couplers in service is a matter on which very many wild statements have been made, on a very small basis of fact. Less is heard concerning the number of such breakages nowadays, since that type of coupler has been generally accepted, by its enemies as well as its friends, as the type which is destined to supersede the old link-and-pin. Still the number of such breakages is a matter over which some controversy still exists, and any reliable figures concerning it are of much value and interest. In publishing in our issue of June 8 the extended statistics collected by the McConway & Torley Co., regarding the percentages of breakage occurring to different parts of the Janney coupler and knuckle, we noted the fact that the total number of couplers covered by the statistics and the actual percentage of breakages were not given. Through the courtesy of Mr. C. P. Krauth, Secretary of the McConway & Torley Co., we are now able to present these figures to our readers. Curiously enough, when they were compiled they were found to approach closely to a convenient form for easy memorizing; and we give them in that form, as follows:

The total number of couplers covered by the statistics presented in our issue of June 8 was 333,333, this being the total number of Janney couplers shipped by the McConway & Torley Co. to March 31, 1893. The average term of service of these couplers was two years. The average percentage of annual breakage of these couplers was 3½%, which, at the prices for repairs maintained by the McConway & Torley Co., makes the average cost of maintenance of couplers 66 cts. per car per annum. Certainly this is a cost of maintenance as low as anyone can fairly ask. There are few parts of a freight car which cost less than 8 to 12% per annum to maintain, and if the M. C. B. coupler can be kept up for between 3 and 4% of its cost, it is a most creditable record. The cost of maintaining the link-and-pin coupler is variously estimated from $1 per car per annum upward, or 10% or over of its cost; that the maintenance of the Janney coupler should be only one-third as high a percentage of its cost speaks much for its design and material.

It is fair to inquire as to the completeness of these statistics of breakages. They are made up from the returns of broken couplers and knuckles made by the several roads to the McConway & Torley Co., and as it is for the financial interest of the roads to report all their breakages it seems a fair conclusion that their returns are substantially complete. The general agreement of the percentages given in the tables in our issue of June 8 is also evidence of some importance. If some of the roads were returning only a small part of their breakages their percentage records would be likely to show a marked difference from those of the others, due to the return of an excess of certain classes of breakages.

It is a question of very great interest whether the percentage of breakages is destined to increase or decrease as we pass the transition stage and the equipment with the M. C. B. vertical plane coupler becomes universal. There are several reasons why an increase of breakages may be fairly expected. There are other reasons why a decreased rate of

breakage may be looked for. It may be of interest to review them.

In the first place it will be noticed that the average term of service on which this percentage of breakage above is given is two years. Now, we always assume that fatality will increase with age. A greater proportion of couplers will be broken when their average age is ten years than when their average age is two years, or else the coupler will be an exception to every other mechanical device. Now, how great will this increase in fatality be? There is considerable reason to believe that it will not be considerable. The coupler is not subjected to constant jar to render it brittle; and except on the inner face of the knuckle it sustains practically no wear. Why then should it be any more likely to break after 20 years' service than after one year's service. So far as can be seen the only effect of service on the coupler will be a gradual weakening due to hard knocks which chip it or start cracks, and as more and more of these injuries are received of course it can endure a less heavy blow without succumbing.

A matter of greater importance in reducing the life of the coupler will probably be the increase of shocks in switching. Trains are growing longer, yard work is heavier, switching engines are more powerful and it is feared at least that the standard of carefulness of yardmen is steadily degenerating. When we add to this the fact that with the automatic coupler a man will not stand between the cars as they come together, it will be realized that we must fairly expect a considerable increase in the average severity of switching shocks.

Now, what have we to offset this to decrease the coupler breakages? First, and, perhaps, most important at the present time, is the application of dead blocks, which have just been made standard by the M. C. B. Association. These will certainly protect the coupler from buffing shocks and from shocks due to the slack running up in trains, except when cars come together with both knuckles closed, which they should not be allowed to do. No one has ever questioned, in fact, so far as we know, that dead blocks were a protection to the coupler; it has only been supposed difficulties in coupling on curves and danger to trainmen making hand couplings which has prevented their general use.

A question which is frequently asked is whether the percentage of breakages will be greater when the coupler meets only those of its own kind, or when it meets, as now, the link-and-pin drawhead 95 times out of 100. The answer to this question depends largely on the answer to the other rather puzzling question, What is the principal cause of the breakages of the guard arm? As shown in our issue of June 8, 80% of the total drawbar breakages affect the guard arm and this percentage is steadily increasing. If this increase is due to the increasing number of couplings made between M. C. B. couplers, then the outlook is certainly discouraging, for the actual number of such couplings is still small. There is good reason to believe, however, that many guard-arm breakages are due to collision with the link-and-pin bar. The link may be jammed in the drawhead so that it will strike a hard blow against the guard arm. Again, when the link-and-pin head meets an M. C. B. coupler with the knuckle missing, or with the knuckle open, it may crowd to one side of the knuckle lugs and bring a heavy blow against the guard arm.

Whatever the cause of the breakages, the latest designs of coupler have the guard arm strengthened, and it is believed by the coupler makers that the percentage of fatality in this part will yet be very materially reduced. If this can be done the chances for decreasing the total rate of breakage much below even its present small percentage seems very good. For when the number of cars equipped with M. C. B. drawbars reaches, say, 75% of the whole, it will be good policy to cease the manufacture of knuckles with the pin slot and pin hole and place solid knuckles on all newly equipped cars and use them for repairs. The solid knuckles will not become numerous enough to make trouble in coupling them with the link-and-pin until the link-and-pin cars become too few to be of importance any way.

We may fairly expect that with the solid knuckle the breakages of M. C. B. couplers will be greatly reduced. Knuckle breakages are at present 92% in the lugs, and 6% worn out. With solid knuckles the breakages should apparently almost disappear, and the wearing surface will be so increased that wear will also become still more insignificant than now. The surplus strength in the knuckle will then be such that the drawbar lugs can be strengthened, and some gain be made here. It is possible, moreover, that the solid knuckle may have less tendency to break the guard arm in striking it than does the present form.

Thus a fair review of the situation enables one to look with much confidence toward continued success for the M. C. B. type of coupler. Its present record is a surprisingly good one, and there is every reason to believe that there is margin enough within the limits of the standard contour lines to enable it to be maintained.

LETTERS TO THE EDITOR.

LARGE SIPHONS.

Sir: I have noted lately several descriptions of large siphons in your paper. While engineer for the Tarrytown, N. Y., Board of Water Commissioners, I constructed two to connect together the three dug wells from which Tarrytown obtains its water supply. One was of 8-in. pipe about 1,000 ft. long, and the other of 10-in. pipe, between 700 and 800 ft. long. The 8-in. pipe was laid on a grade of about 0.4 ft. per 100 ft., rising from each end to the center, at which place the air chamber was placed. The 10-in. pipe was laid on about 0.5 ft. per 100 ft., rising toward the inlet end. The air chamber on this siphon was located about 30 ft. from the intake leg.

The main portion of the siphons were of light weight ordinary bell and spigot coated cast iron water pipe. The legs, elbows and first lengths were of flanged pipe. The legs were each about 22 ft. long, and the siphons have raised water nearly this height, but ordinarily work under a much smaller head. Each siphon was connected with the force main for filling purposes. On the inlet leg of each siphon was placed a foot valve, and on the outlet leg a geared gate valve with a stem reaching to the top of the well, to which was attached a hand wheel. The material through which the siphons were laid was very bad, being swampy and composed of muck underlaid with quicksand. Piles of 2×8-in. spruce plank had to be driven for nearly every length of pipe. Each length of pipe was set to true grade with a wye level. Around each air chamber a manhole of brick was built. When the siphons were first put in operation they worked very well, running for about a week without recharging, but I am informed that a leak has been sprung somewhere lately, and they need partly recharging now about once every one or two days. They have been in use now about 18 months. Yours very truly, W. C. Foster.

CENTRAL PERUVIAN RAILWAY.

Sir: In your issue of June 15 there is an item about the Central Peruvian Railway which is not correct in a few details. There are more tunnels and more switchbacks; the former being 56 in number, and the latter 73; three of these are over 13,700 ft. above sea level. The two bridges are over 15,000 ft. above sea level, and all concerned in the erection of them have a very vivid recollection of the increased difficulty and expense caused by the ac...nal 4,000 ft. in elevation.

James R. Maxwell,
Late Chief Engr. and Supt. of Construction for the Contractor.

Media, Pa., June 16, 1893.

FIREPROOF FLOOR CONSTRUCTION.

Sir: In your issue of Nov. 9, 1889, under the heading of "A New System of Fireproof Floor Construction" you published a description of the Guastavino system. This system is now in extended use here and abroad. I understand, and I believe your publication has principally contributed to this success. Under these circumstances I ask for the privilege of criticising some of the figures used in the article.

Your correspondent refers to a new system of construction, arches made up of several layers of tiles joined together alternately with plaster-of-Paris and a "secret" cement. As a proof of the reliability of the system he refers to two tests made with arches with three layers of tile breaking joints, and showing after two months a tensile strength of 1,378 lbs., and after two years, 3,290 lbs. per sq. in.

The weakest section in this test arch is evidently made up of two-thirds cement and one-third tile. Trautwine's highest recorded tensile strength for cement is that found by Mr. Eliot C. Clarke; that is, after one month, 412 lbs., and after one year 494 lbs., per sq. in. We take the latter and find the tensile strength of the tile by the following formula:

$$\frac{2}{3}\,494 + \frac{1}{3}x. = 3{,}290$$

$$x = 8{,}880 \text{ lbs. per sq. in.}$$

This is a very high figure in any case, while the peculiar increase in strength during the two years remains to be explained. I do not believe it can be explained in any ordinary way. But it is unimportant after all, as I wish to show that these figures have no value at all in arch construction.

In cases of tension only the stress in the testpiece will be distributed proportionally according to the equal expansion. In cases of bending the outer fiber will always carry the greatest share of the stress, and the difference in the moduli of elasticity will not materially decrease the figures to be given. We cannot consider either 3,290 or 1,378, but must take 494, lbs. per sq. in. as the breaking limit for cement.

We will take for calculation an arch of 12 ft. span, 14 ins. rise, and three layers 3.25 ins. thick. For this span we find given a safe load of 615 lbs. per sq. ft., and assuming 50 lbs. as dead load, we would find that when the whole span is loaded there would be a compression of 330 lbs. per sq. in. and no tension. Under the most dangerous condition, with only one-half of the span loaded, we find about 2 ft. from the center a tension of 560 lbs. per sq. in., of course in the outer fiber only. But we also see that with this "safe" load we reach the breaking limit. Your correspondent gives a breaking load for this arch ten times greater, and in that way overtops even his own high figures for limit of rupture after two years.

It may be said finally that this safe load of 615 lbs. per sq. ft. is exaggerated, like most other figures in this article. For building purposes, where the average loading seldom exceeds 150 lbs. per sq. ft. the system doubtless has a very broad margin of safety. But I trust your correspondent will pardon me for saying that, until more trustworthy tests are published, most people will find little difference between the Guastavino and any other tile arch.

Tile arches have some advantages for building purposes; but if you want a really strong arch you must use concrete. It may be of interest to your readers, as your journal has recently described the well known Monier system of arches, to say that a similar system has recently been tested in Austria and is deemed superior to the Monier arch. It is patented by Prof. J. Melan, and he substitutes I-beams for the iron rods of Monier near the intrados only, and he claims that the entire supporting strength can thus be doubled.

Tests have been made of this arch by a board of the Austrian Society of Architects and Engineers, and they establish the fact that the adhesion of the cement to the iron (650 lbs. per sq. in.) is far greater than the tensile strength of the cement itself. Cracks never appeared between the two materials. This same board is investigating all types of floor construction in use in Austria, and will probably publish its report next winter. It promises to be one of the most exhaustive and valuable reports on this subject ever issued.

Yours truly, Subscriber.

New York, May 3, 1893.

(We submitted a copy of this letter to the Guastavino company, and Mr. Guastavino writes that absence from the city and lack of time have made it impossible to attend to it before. He says: "After reading the paper sent me, I would say that the best answer I can give is to refer you to a lecture delivered by me about three years ago before the Society of Arts, of the Massachusetts Institute of Technology, and which was published in a book on 'Cohesive Construction.'" We have received from Mr. Guastavino a copy of this book, which deals with concrete and tile construction generally, but he makes no specific reply to our correspondent's letter, which we therefore print without further delay or comment.—Ed.)

CONCERNING THE STATUS OF ENGINEERS.

Sir: It seems to me that there is a common idea running through the most of the communications lately published in your journal and relating to the professional status of engineers. This is a feeling that a large ignorant element is taking to itself the bulk of the benefits of engineering science and labor. To counteract this, engineers themselves must work toward some definite end, and strive to educate the public up to a due and proper appreciation of the real status of the engineer. This is slow work, and the only present hope for better things lies in the continued discussion of this subject.

In this line, therefore, I wish to add a few suggestions to my letter published in Engineering News, of Feb. 16, 1893, and I give them for what they are worth:

I believe it is possible for engineers, after a reasonable period and with some energetic work, to place themeselves upon the same basis as are the notary publics in European countries. This means that, after they have fully established their fitness, they would have authority to perform and to certify engineering work of a certain character; that they would be held

responsible for their actions; be no burden upon the government and yet be free from political influences. To accomplish this, these "public civil engineers" should receive a license from the general government upon the recommendation of a properly constituted board. This board would have to be non-political and compare with the Supreme Court judges. Its members should be selected from prominent members of engineering societies, professors in technical schools, and men of large business experience in matters pertaining to engineering. Any movement in this direction should apply to the country as a whole to avoid conflicting laws as passed by the several states, and to permit an engineers to practice with equal rights in any state.

For the present and for some years to come these licenses should only be given to engineers over 30 years of age, who have proved their competency by their works. Special regulations should be framed for the benefit of the younger members of the profession. There should be no Chinese wall around the profession of engineering, and it should be open as a profession to the poorest in the land. But as engineering is a scientific profession, whoever enters it should first prove that he is actually what he claims to be. It concerns nobody how an engineer got his theoretical knowledge and his practical experience; but it is important to very many that he be competent and experienced when he claims the title of engineer and practices the profession of scientific construction.

It would seem to me a good thing for the general advance of the profession to employ two secretaries, one in the Eastern and one in the Western states, to collect the statistics of engineering, to study the business relations of engineers, and to thus create an office for information and advice in special cases.

The root of the present evil, as your journal has frequently mentioned, is the employment of too large a number of engineers on daily and monthly pay, generally without any existing contract between the employer and the employed. This evil cannot be corrected for some time to come. But engineers could with good results insist upon contracts and have them drawn for a certain time, with a provision for a gradual rise in salary and some bonus or extra remuneration due at the expiration of a contract faithfully carried out. Engineers in responsible positions should assist younger engineers in securing distinct contracts. I also agree with Mr. B. S. Church that the payment of a percentage on the cost of the work, in lieu of a salary, is a step in the right direction and should be insisted upon by engineers of reputation.

Very respectfully,

Cleveland, O., June 12, 1893. F. Felkel.

(As our correspondent suggests, these ideas must be taken for what they are worth. Theorectically the plan is a good one, but practically there are many difficulties in carrying it into effect. It would doubtless be a very good thing for competent engineers if laws were passed compelling all corporations and parties erecting works of any kind over which the public were to be transported to have the structure designed and erected and its safety certified to by duly authorized and officially recognized engineers. But the engineers must also be bound and made responsible for their work; and herein comes the difficulty as far as practical results are concerned. Engineers as a class are by no means wealthy; and if it is a question of responsible bondsmen, the list of practicing engineers would be rather a short one, we fear. Then, official recognition by the general government of members of any profession is not the practice in this country, and it would be very difficult to make the engineering profession an exception to the rule. We believe that engineering contracts somewhat on the lines indicated would be well for engineers; but practically, the young applicant for an engineering position with any corporation usually stands with his hat in his hand and gladly accepts employment on almost any terms offered. He unfortunately knows that a crowd of applicants for the same place are on the other side of the door, and he is not in a position to demand and fix the terms of a contract. For reasons already given, we do not approve of the percentage basis of payment in place of a salary; it is almost impossible to fix in large engineering works, and opens the door to charges, at least, of a lack of fidelity to the interests of the employer.—Ed.)

Active work on the Louisville-Jeffersonville Bridge has been begun by the Phoenix Bridge Co., and it is proposed to have the structure completed by Oct. 1. The superstructure consists of six spans, two of 550 ft., two 341 ft., one 553 ft., and one 210 ft., with an iron viaduct approach 4,073 ft. long on the Jeffersonville side, and a similar approach 2,740 ft. long on the Louisville side. The substructure, consisting of seven masonry piers, is practically complete.

TESTS OF THE M. C. B. COUPLERS.

We gave last week the principal facts in connection with recent tests of M. C. B. couplers made by the Western Railway Club. At the convention of the M. C. B. Association last week a report was made regarding the tests which have been made by the Association committee consisting of drop tests carried on at Altoona, Pa., and pulling tests made on the Emery testing machine, at Watertown Arsenal. The various makers of couplers were invited to submit four couplers to the drop tests and eight to the pulling tests. The tests were made by Messrs. D. M. Perine and G. C. Bishop, of the Pennsylvania R. R. Department of Motive Power. The following is the substance of their report:

The drop test machine was provided with a stone foundation 5 × 5 ft. on top and 8 × 8 ft. at the bottom, and 5 ft. deep. The bedplate of the machine, made up of four round boiler plates ½ in. thick and 42 ins. in diameter, riveted together with countersunk rivets, was bolted down to this foundation with six anchor bolts. The guides for the weight were two 85-lb. steel rails, 6¾ ins. apart. The coupler to be tested was fastened between them by means of keys and wedges. The weight was made up of two castings and a hammer with a 4 × 10-in. face, the whole weighing 1,640 lbs. The weight was lifted by an 8-in. air cylinder, 8 ft. 6 ins. long, connected to a ½-in. steel wire rope run over pulleys in such a manner as to double the lift.

An ordinary tripping hook was used to trip the weight, and the tripping irons were arranged one on each side of the machine, at a height to trip the weight at 10 and 15 ft., respectively. By this arrangement it was only necessary to turn the arm of the hook toward the front of the machine to have it trip at 10 ft., and toward the back of the machine to trip at 15 ft.

The weight was dropped on the coupler held in position, as described three times from a height of 10 ft., and from 15 ft. until the coupler was broken. After each of the first six blows the knuckle opening was measured, and the condition of the knuckle lock pin and shank noted. The coupler was also adjusted after each one of these blows, so that the blows were received as described. After the sixth blow the coupler was not readjusted, but the blow was taken wherever the bending of the shank permitted it. In this way many guard arm tests were made, the shank often bending so as to permit the weight to strike between the knuckle and guard arm. In the specifications adopted by your committee it will be remembered that mention was made of the weight striking a piece of steel so arranged as to distribute the force of the blows. This was tried and abandoned, as it was found after the first blow when the knuckle became bent the full force of the blow could not be delivered, as the steel, when struck by the weight, would glance off the knuckle. This was only used for two blows on two different couplers, and did not in any way affect the test.

In the pulling tests, after adjusting the coupler in the machine, a load of 2,000 to 3,000 lbs. was brought to bear on the coupler, and the original openings of the knuckles were then measured with a steel scale in a line drawn through the link pin-hole parallel to the center line of the shank, the measurements being taken between the faces of the drawbar heads and inside faces of the knuckles. Loads of 75,000, 100,000 and 125,000 lbs. were then respectively sustained for a sufficient time to obtain the measurements of the knuckle openings, and the load was then increased to destruction.

After testing a set of couplers, in almost every case four uninjured bars remained, and these were used for single lug and drawbar tests in the following manner: Out of the four remaining bars the two best were picked, and, tailbolts being inserted, were coupled together, the upper lug of one to the lower lug of the other. The tailbolts were so adjusted in the machine that the face of the knuckles were kept parallel, and the bars pulled to destruction. Drawbar tests, that is to say, drawbars without any knuckles, were then made as follows: The best remaining drawbars were picked out, and the knuckle, pivot pin, etc., removed. A steel tailbolt was then inserted, and a special forged steel fixture, having a shank 3 ins. square by 20 ins. long, for gripping in the machine, was coupled to the drawbar by a steel pin of high carbon in place of the knuckle. The drawbar was then pulled to destruction, and a record kept of the load required; also of the location of the fracture.

In the drop tests it was shown that the steel not only had the advantage of being stronger than the malleable bar, but that it also was stronger than its knuckle, which is an important advantage, as the knuckle is the easiest and least expensive part to renew. The reverse is true of the malleable bar, it being weaker than its steel knuckle, as shown by the tests. This appears from the fact that of 75 couplers tested, 40 of steel and 35 malleable, out of the 40 steel couplers six knuckles broke on or before the second blow at 75 ft., and but one steel drawbar was broken. Out of 35 malleable couplers no knuckles were broken on or before the second blow at 15 ft., yet 27 of the drawbars were broken.

Results of Tests of M. C. B. Couplers.

Name.	Material. Coupler.	Knuckle.	Pivot pin.	Ave. wt., lbs. C'pl'r.	Knuckle.	Diam. pivot pin, ins.	No. of pas'ing parts.	No. gage.	Pulling tests.—Average strength, lbs. Couple r.	Single lug.	Bar.	Drop tests, ave. No. blows to break.
Chicago	O. H. steel	O. H. steel	Steel	219.1	53.3	1⅛	7	–	180,400	154,600	209,500	17.0
Standard	..	Pr'ss'd st'l	"	221 9	66.5	0	4	1	157,350	106 000	no pin hole	8 5
Buckeye	Mall. iron	O. H. steel	"	224.5	58.1	1⅛	8	5	154,570	132,200	125 800	6.8
American	O. H. steel	"	"	224 9	52.3	1⅛	10	3	153,450	....	219,900	12.5
Drexel	"	"	"	201.3	57.9	1⅛	7	3	152 300	120,500	214,100	7.3
Perfected	"	"	"	213.7	49.9	1⅛	11	0	146,925	127 100	....	6.3
Brown	"	"	"	229 5	36 8	1⅛	12	0	144,030	99,600	139,900	5.8
Trojan	Mall. iron	"	"	216.5	52.3	1⅛	7	2	132,850	98,500	143,600	3.8
Gould	"	"	"	203.3	61.2	1⅛	9	0	132.193	86.850	120,180	4.8
St. L. uis	O. H. steel	"	"	211.9	50.8	1¼	6	..	132,050	116,100	.....	4.8
Thurmond	Mall. iron	"	"	265.1	70.5	1¼	8	..	130.125	107,600	.....	6.3
U. S.	O. H. steel	"	"	243.5	54.4	1⅛	5	1	126.650	137,160	226.800	18.3
Hinson	Mall. iron	"	"	218.7	35 4	1⅜	8	5	125,000	98,700	135,100	7.5
California	O. H. steel	"	"	223.6	32.1	1⅛	7	.	123,475	70,0 0	139,900	12.5
Rivers	"	"	"	255.0	37.0	1⅛	4	0	118,725	119,200	....	1.8
Janney	Mall. iron	W. iron	"	213.4	37.4	1⅛	10	1	90,413	71,400	185,200	4.3
Johnson	"	O. H. steel	W. iron	176 6	35.8	1⅛	11	0	71,850	50,9 0	117 100	3.5
Ludlow	"	Mall. iron	Mall. iron	222.4	68.8	2¼	12	0	69,375	50,800	79,950	.....

It was also evident that the shanks of the malleable coupler showed the most weakness, as 69% of the malleable bars broken broke in the shank, whereas only 28% of the steel bars broken broke through the shank. Holes in the malleable shanks for different purposes weaken them considerably, as many of them broke through such holes. This was not noticeable in the steel bars.

Wrought iron pivot pins bent so as to make the knuckle inoperative after a few blows, while with steel pivot pins, and the same construction of bar lugs, they were in some cases operative after 10 blows.

In the pulling tests the importance of a pivot pin of high carbon was clearly demonstrated, it being obvious that soft steel for this use was entirely unsuitable. For example, many bars had the pivot pins sheared off at a load much below what was actually required to fracture either the bar, knuckle or lock, or else had the pin so badly bent or sheared as to make the knuckle inoperative, and the coupler, in this form, entirely useless for service. Again, the destruction of the bar may occur by the use of a weak pin, as was shown by a pivot pin shearing off close to one drawbar lug, and then acting as a lever to fracture the other drawbar lug.

Total and Averages of Bars and Knuckles Broken in Drop Tests.

Kind of bar broken.	No.	Total blows to break.	Ave. blows per bar.	Per cent. of bar broken.
Steel	13	133	10 2	28 %
Mall. iron	35	192	5.5	100
Total	48	325	....	....
Knuckles:				
Steel	29	246	8 5	40 %
W. I	0	...	..	....

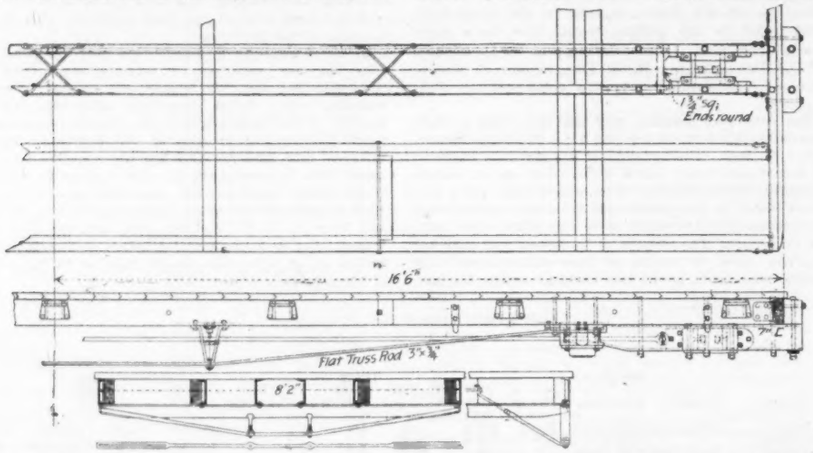
The single lug tests show in most cases that one lug was able to stand a load of over 90,000 lbs., although many stood over 125,000 lbs. The drawbars, with knuckles entirely removed, show themselves generally to be strong enough to stand a load of over 125,000 lbs., some standing as high a load as 200,000 lbs., and one breaking at 226,800 lbs. Very few shanks were broken, proving that they were amply strong to stand the yoke or tailbolt strain.

It was found that most knuckles are weak through the pivot pinhole, and that steel pivot pins of high carbon should be used, greatly increasing the strength of the coupler. Simplicity being an important feature, it would be well to use as few parts as possible in coupler construction.

We regret that on account of the limited time we were unable to enter into guard arm tests as fully as we would like to have done, and feel sure that suitable tests can be devised to thoroughly test this part. We hear, however, that many guard arms are already being strengthened.

The prescribed M. C. B. specifications for the drop and pulling tests we do not consider in any way too severe, and would advise that they remain the same.

A great deal of useful information concerning the construction of a drop has been gathered from this test, as we found that it was impossible to keep the foundation from giving way, and we feel sure that were we given time we could construct one that would stand all the strains without injury. Two important facts in the construction of a machine of this kind were made evident. 1. That the only proper form of bedplate to use is a large casting, the larger the better, but not less than 5 × 5 ft. square, containing enough metal to take up in the mass all shocks and recoil, and placed upon a steam hammer foundation. 2. That the only proper way to test a coupler is to hold it securely in the machine, while it is being tested, and allow it to receive the full force of the blow, which we do not think can be accomplished in any other way.



STEEL UNDERFRAMES OF ROLLED CHANNELS, RIVETED; LAKE SHORE & MICHIGAN SOUTHERN R. R.

The benefits derived from recent tests of this kind have already been demonstrated, as couplers that failed in the Chicago tests have been so strengthened by a change in material that they have been thoroughly able to stand the tests conducted by the M. C. B. committee.

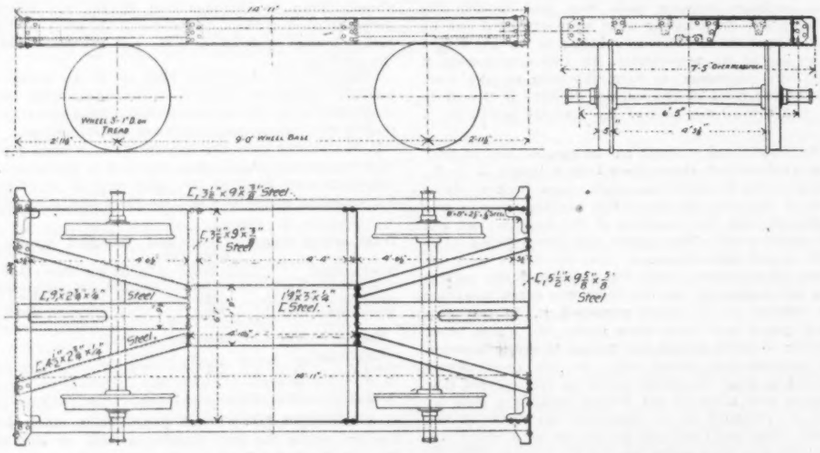
STEEL CENTER SILLS FOR FREIGHT CARS.

The following report was presented by D. L. Barnes, J. N. Barr and J. D. McIlwain, at the annual convention of the Master Car Builders' Association held last week at Lakewood, N. Y.:

The experience in this country with metal center sills and metal under-frames is quite limited, and it is impossible to gather from it much that is definite or conclusive. The experience here has been confined to the following:

(1) Metal under-frames for locomotive tenders. (2) Several metal under-frames on the New York Central and the Lake Shore & Michigan Southern roads. (3) Sixty cars of the first type built by the Harvey Steel Car Co., used principally on the Chicago, Milwaukee & St. Paul R. R. (4) Several tank, box and gondola cars recently built by the Harvey Steel Car Co., on an improved plan, from designs of Mr. J. D. McIlwain. (5) Various special cars for unusual freight, built by several railroads, principally the Pennsylvania. (6) The Michigan Central R. R. has made an investigation of the subject, and has proposed a metal underframe from designs of Mr. Robert Miller, Gen. Supt.; Mr. E. D. Bronner, Supt. Car. Dept., and Mr. Robert P. Lamont, Mechanical Engineer. (7) Several designs have been made by the Fox Solid Pressed Steel Co., of Joliet, for cars for the Illinois Steel Co. (8) A considerable number of cars have been built with iron pipe under-frames, but these are scarcely practicable and are not of a type that would ever be generally used, and therefore have been omitted from this report.

Nothing has resulted from the experience of those who have been using the above-mentioned cars that leads to a strong conviction for or against the use of steel center sills. It has, however, been found on the Lake Shore road, that running repairs are much less with the steel under-frames. Steel tender frames have been annoying in repairs, not on account of the total cost, but because when the tender is disabled the locomotive to which it belongs has to be taken from service. But few tenders are kept for extras, and owing to the delays incident to repairing steel tender frames they are not considered favorably by the majority of railroad men; but as steel frames for tenders are stronger than wooden ones, and by their increased strength and durability have reduced repairs, there are some who believe them to be more desirable than wooden frames. One marked advantage has been found in the freedom from decay. It is practically impossible to make a steel tender frame that will not be distorted more or less in such collisions and wrecks as break up and damage wooden ones. Hence, a logical conclusion is that the delay in repairing steel under-frames makes them less practicable than wooden frames for locomotive tenders under the present method of operating locomotives. With freight cars, of course, the case is different, as the delay in repairing freight cars does not extend to locomotive equipment.



PRESSED STEEL UNDERFRAME, RIVETED; ENGLISH RAILWAYS.

In England, where wooden under-frames are very much heavier in proportion to the carrying capacity of the cars than is common practice here, steel under-frames are gradually being introduced, both for freight and passenger cars. The reports of service are very decidedly in favor of metal under-frames.

In Germany, Belgium, Sweden, Norway, Russia, France, India and on some roads in Mexico, and in nearly all foreign countries, the metal under-frame is regular standard practice. Perhaps no argument is necessary to show that, in countries like Germany and France, where the cost of repairs to cars has been reduced to a point below the cost in other countries, the maintenance of a metal under-frame costs less, under the conditions of operation there existing, than the maintenance of wooden frames. Frequent reports by the government railway officers of France and Germany prove beyond doubt that metal under-frames, for both passenger and freight cars, are more economical and better adapted for service in those countries than wooden ones, and further discussion of this point has been omitted, believing that the statement would be accepted without more evidence, and this report has been more particularly confined to descriptions of typical designs of metal frames used in various countries.

The advantages that may be expected from the use of metal center sills lie almost solely in the increased durability and the reduced cost of inspection. A metal center sill, when it is properly made, is the equivalent of a continuous drawbar arrangement from end to end of the car; and being composed of material having a high tensile strength, steel center sills can be readily made so secure as to require but little inspection. The center sills of a car and the draft rigging attachment are the parts of a car body which require the most attention from car inspectors, and cost more to maintain than other parts of the car body; therefore, it might be expected that the introduction of steel center sills would reduce the cost of running repairs.

In case of wrecks, it is a question whether the steel center sills would not be more expensive to repair than wooden ones, but the total cost of repairs to center sills and draft riggings caused by the class of wrecks which would seriously damage a steel center sill is not very large; and although the use of a steel center sill might increase materially the cost of repairing center sills after bad wrecks, yet, owing to the fact that on a well appointed road bad wrecks are not numerous, the result would not be an increase in the total cost of all repairs; in fact, the greater durability of a suitable steel center sill ought to so reduce running repairs as to give a decrease in the total cost of all repairs to car bodies. It is, of course, true that wooden sills frequently last for 15 years where the cars receive reasonably good service; but the present tendency is to use a subsill the entire length of the car to prevent damage to top and draft sills. With the present heavy equipment the result of this is that the total weight and cost of a car are greater with the present construction of wood than it would be with steel center sills at the prices at which steel is now offered. In any considerable quantity, steel sills can be purchased for less than 2 cts. per lb.

An examination of existing designs and a review of the experience of those who have been in direct contact with the repairing of steel under-frames, indicate that the following are some of the essential features of metal under-frame construction:

1. All joints should have sufficient area and rivets and bolts sufficient in size and number to prevent movement of the parts one upon the other when the cars are in service.

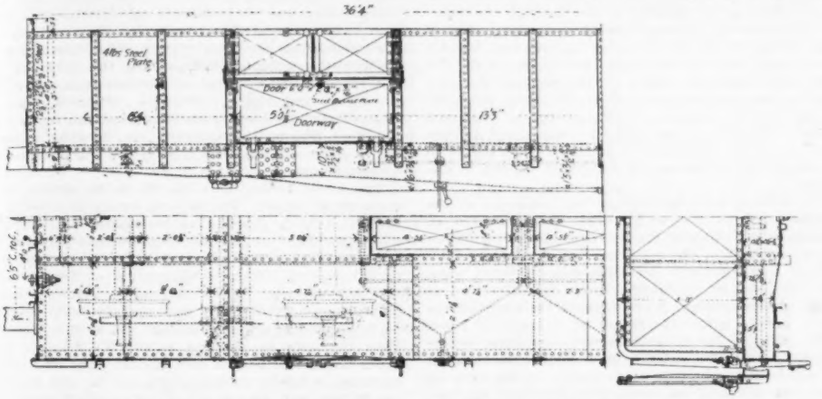
2. All joints should be so designed as to permit repairs to be made with the least possible delay and manipulation, and if possible without heating.

3. As far as possible the center sills should be continuous from end to end of the car.

"IS THE GAME WORTH THE CANDLE?"*

By John Thomson, M. Am. Soc. C. E.

The assertion is ventured that there are 50 water-works men to-day where there were but five ten years ago who not only strongly believe in and advocate the use of water meters in general, but who also believe that every new service connection ought as uniformly to be provided with a meter as with a stop-cock. Undoubtedly, however, the element of cost is a considerable limitation to such a general introduction and use of meters, and this at once leads to a second assertion, that the principal limitation to the reduction of prices for water meters is largely due to the degree of sensibility required at low rates of flow and the capacity to also safely operate under conditions involving high rates of delivery.



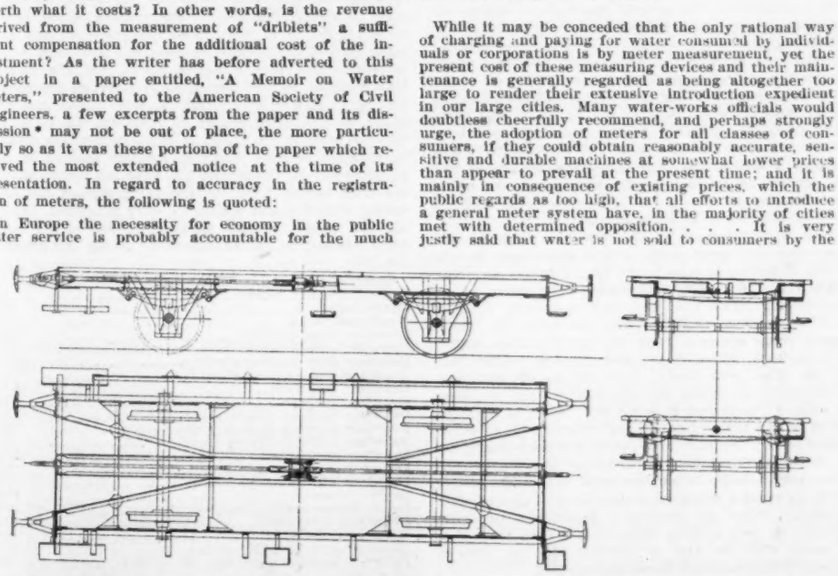
STANDARD PRESSED STEEL UNDEPFRAME, RIVETED; INDIAN STATE RAILWAYS.

For ordinary domestic service is a high degree of sensibility in water meters at low rates of discharge worth what it costs? In other words, is the revenue derived from the measurement of "driblets" a sufficient compensation for the additional cost of the investment? As the writer has before adverted to this subject in a paper entitled, "A Memoir on Water Meters," presented to the American Society of Civil Engineers, a few excerpts from the paper and its discussion* may not be out of place, the more particularly so as it was these portions of the paper which received the most extended notice at the time of its presentation. In regard to accuracy in the registration of meters, the following is quoted:

In Europe the necessity for economy in the public water service is probably accountable for the much greater use of meters which there exists than in America. It is certain, too, that the employment of meters abroad has resulted in a satisfactory reduction of the water-waste, notwithstanding the fact that this has been largely accomplished by the use of the low-priced and comparatively inaccurate types of inferential meters. Hence, there is here presented the apparent necessity for close measurement, but with satisfactory economical results being derived from the employment of what is generally conceded to be the most inaccurate type of domestic water-measuring instruments.

With us, however, it is but a slight stretch of poetical license to say that, when the water-works engineer, who for years has stood complacently by while water has been wastefully served at from 75 to 150 gallons per capita per day, who then suddenly concludes to apply a few meters to check this lavishness, his economy goes not only to the dollars but to the pennies; the meter is required to measure down to drops, and a standard of accuracy is not infrequently set up which but few laboratories have the means of verifying, and fewer water-works employees the ability to carry out.

The point of this is that for all practical purposes, in ordinary public service, a meter which would register within 5 or 7% of accuracy, between fair minimum and maximum rates of discharge, is, in the writer's judgment, as in that of many others, amply accurate to affect the desired purpose. And when our water-works officials will have arrived at the same conclusion, meters may then be purchased at a discount from present prices of from 20 to 25%. Furthermore, such a standard of accuracy would, in ordinary practice, result in decreased cost of maintenance and increased life to the meter, because of the practical conditions of service under which meters are frequently set.



STANDARD STEEL UNDERFRAME OF ROLLED CHANNELS, RIVETED; GERMAN RAILWAYS.

A portion of a rejoinder by Mr. Emil Kuichling, M. Am. Soc. C. E., is as follows.

While it may be conceded that the only rational way of charging and paying for water consumed by individuals or corporations is by meter measurement, yet the present cost of these measuring devices and their maintenance is generally regarded as being altogether too large to render their extensive introduction expedient in our large cities. Many water-works officials would doubtless cheerfully recommend, and perhaps strongly urge, the adoption of meters for all classes of consumers, if they could obtain reasonably accurate, sensitive and durable machines at somewhat lower prices than appear to prevail at the present time; and it is mainly in consequence of existing prices, which the public regards as too high, that all efforts to introduce a general meter system have, in the majority of cities met with determined opposition. . . . It is very justly said that water is not sold to consumers by the drop or driblet, but by the gallon or the cubic foot, as the smallest practical unit. To this statement no one should take exception, but it is also fair to take it literally. Let the meter be sensitive enough to record, even with wide margin of accuracy, the fact that hundreds of gallons pass through it in the course of a day, and it will be a far more useful instrument to the community purchasing it than one which will exhibit marvelous accuracy in the measurement of comparatively large streams, and yet allow small flows to escape without detection. The percentage of error in registration of a meter is therefore a matter which should be sharply defined, and should be made dependent upon its sensitiveness. . . . In the case of meters intended for family use, which in a general meter system would vastly outnumber all other kinds, it is, therefore, essential to make sensitiveness a paramount feature, as well as durability and cheapness. The same requirements may also be made for meters, for the majority of manufactories and places of business in a community; and in the comparatively few instances where the draft is constantly large, special meters which give a high degree of accuracy can easily be applied.

In conclusion, therefore, it may be stated that a thoroughly serviceable meter would have a large sensitiveness, but need not have a very high degree of accuracy. How these qualities can be combined with durability and economy is a question whose solution is left to the skill of inventors.

To Mr. Kuichling's discussion, still referring in particular to the matter of accuracy, the following reply was made.

As to lowering the standard of accuracy, this is a suggestion which I made with considerable hesitancy, as it might be taken as appearing to advocate a step backward. Nevertheless, I am of the opinion that, in at least the great majority of instances in which meters would be comparatively largely employed, the fact of whether or no they indicated at comparatively low rates of flow would bear but a very small relation to the total advantage and revenue derived therefrom. The point made by Mr. Kuichling to permit a lowering of the standard of accuracy, while yet retaining the element of sensitiveness to such a degree as to at least indicate a portion of the entire quantity at the lowest practicable rates of discharge, is somewhat in line with the results obtained in the use of the low-priced inferential meters, a type but little known in this country. This is a condition of operation, however, which would probably be very difficult to obtain, if at all, in the existing types of positive displacement meters.

In the first of the foregoing quotations the point was not made as clearly as it should have been, that an accuracy limit of from 5 to 7% was intended to refer in particular to operations at low rates of flow, because it is a fact that nearly, if not all, of the existing types of positive displacement meters may be calibrated to indicate with practical accuracy through a wide range in rate of delivery, although not capable of registering at a predetermined low rate of flow. The reason for this is that until the static resistance of the device is overcome, the freely fitted parts permit leakage, but immediately the mechanism is put into operation the error, if represented graphically, as by a line, would rapidly rise until at and beyond a given rate of flow the leakage, or slip, becomes practically constant and will remain so, provided excessive wear of the parts does not take place. Now, in the instance, say, of a tightly fitted piston or any equivalentally positively operated device, which requires a considerable fall of pressure to operate it, the tendency is at once increased to cause leakage, or increase of slip, and by this very fact to increase the likelihood of carrying particles of fine dirt or sand between the bearing surfaces. Again, the immediate consequences of such introduction of foreign particles is, by action analogous to that of a wedge, to still further increase the resistance of the device and wear of the parts.

Thus in a machine, the first and the desirable effect of wear upon the journals is to bring the surfaces into more intimate contact by working down the high parts which first impinge against each other; but in a meter, referring to the instance being illustrated, the opposite effect is incited, that is, to decrease the intimacy of contact and provide a free film of water between the parts. There are thousands of meters in actual service to-day performing well, returning a satisfactory account of their stewardship and earning a proper revenue, which if now tested at many of the low-rate requirements would not pass muster and yet there has been accomplished upon the meter by wear of its parts what had probably been best definitely performed mechanically, that is, its bearings have been ground to a clearance.

What has just been said refers, as it will of course have been understood, to meters set under ordinary direct (and not tank) service, which is the only proper condition to which modern compact "rotaries" and also many of the piston types of meters, are adapted. Now, the writer is not prepared to take a strong position on this matter, rather hoping to derive information from the discussion of others more competent nevertheless, he is strongly inclined to the opinion that, for the regular direct domestic service, a comparatively slight lowering of the usual standards of sensibility in the presently popular rotary meters would be of mutual advantage, both to the purchasers of such meters and to the manufacturers thereof. The advantage to the purchaser would be increased durability and decreased cost, the two probably being of greater value than the quantities lost by lessened sensibility. The advantage to the manufacturer would probably be in the increased demand for his product, which, when taken together with the decreased cost of manufacture and calibration, would more than compensate the reduction in price. Consequently, the benefit would be mutual.

The extreme positions taken on this subject by engineers of recognized ability is a lesson in the power of human judgment to distend without passing the elastic limit. Thus in a further discussion of the paper referred to, Mr. D. McN. Stauffer, M. Am. Soc. C. E., formerly city engineer of Philadelphia, said in Engineering News:

In a memoir upon water meters, read last week before the American Society of Civil Engineers, at Lookout Mountain, Mr John Thomson justly remarked that there is a demand on the part of corporations for altogether too much accuracy in water-measuring machines. He says that an error of 5 to 7% would really be unimportant when the essential purpose of a water service is considered; and that the resulting gain from this allowance of error would be a much less costly and yet a more durable meter. We fully agree with Mr. Thomson. Water is sold by the gallon and not by the drop;

*The following statistics were given in presenting the report: Of the total cost of freight car repairs only 6% is due to repairing and rebuilding cars destroyed in wrecks, of which 3% is due to rebuilding of cars completely destroyed. This leaves only 3% as the proportion of repairs due to injuries of cars in wrecks, indicating that a very small saving in the present frequent repairs on wood center sills would overbalance any loss due to increased cost of repairing cars injured in wrecks.

Abstract of a paper read at the annual meeting of the New England Water-Works Association, at Worcester, Mass., June 14, 1893. The full paper, with discussion, will be published in the Journal of the New England Water-Works Association.

*Trans. Am. Soc. C. E., vol. xxv., June, 1891.

and the only reason for measuring it out through a meter is to closely approximate to the actual quantity furnished, and to thus check the wholesale waste prevalent under the older methods of service. A few hundred gallons more or less, in a year, in the amount furnished to a consumer, is of little real importance; but it is important to stop the same man from absolutely wasting thousands of gallons in the same period. Water is a commodity that should be made as nearly free as possible for all legitimate use; and a serviceable meter is the best regulator of this legitimate use. Its utility is fully recognized by all purveyors of water, and the comparatively expensive character of the machine and the cost of keeping it fully up to established standards of accuracy are the only limits to its common adoption. If the small error mentioned by Mr. Thompson will enable the price to be reduced from 25 to 30% below present market prices, and at the same time furnish a meter that will cost less in repair, there seems to be no good reason for rejecting his advice. A change of this kind would at once vastly extend the use of meters, and no one can question the gain in waste prevention, as compared with the older and very reckless methods of furnishing water. With only six meters, as yet, to every 100 taps in the United States, our readers can judge for themselves of the field still to be covered by this useful regulator of domestic and general water supply.

Then Mr. Robert Cartwright, M. Am. Soc. C. E., basing his judgment upon an experience with some tens of thousands of gas meters, says that he is prepared to reduce the water waste to a satisfactory rate by the simple use of meter casings having no internal mechanism whatever, upon the theory that the moral effect upon individuals who suppose that the water which they are using is being measured would have the desired result. On the other hand, Mr. Kuichling has pointed out, with an incisiveness which may well make the "meter man" wince, that the maintenance of meters "is generally regarded as being altogether too large to render their extensive introduction expedient in our large cities." And yet the requirements which he would insist upon are precisely those which both increase the cost of the meter and render it more likely to become damaged in practice. The query may well be here injected if a saving in first cost and in cost of maintenance were invested in additional meters, would not the sum total of receipts and results be upon the side of the municipality?

The second application refers to an opportunity open to the purchasers of water meters, and one which is almost entirely to their advantage, having in mind the existing state of the art. This refers to the selection of the proper size, or capacity, for the maximum service intended. In the aforementioned paper this was briefly referred to as follows:

> One of the most difficult experiences met with in practice has been to make clear to many water-works superintendents that, in selecting the size of a meter, conditions of operation have frequently much more to do with the quantity discharged than the mere matter of pressure. . . . From whence it follows that probably three-fourths of the meters in public use to-day are considerably underworked; and that, if proper judgment could be depended upon in selecting the capacity of the meter to the duty to be performed, still more compact and less expensive nominal sizes might be the result.

The opinion then expressed has been but strengthened by experience meantime gained; and while there is no more exasperating and inexcusable fault than to set a meter so as to be damaged by over-running, a fault promptly made evident, but little is ever said or known regarding the opposite condition, that is, under-running, which prevails to a much larger extent than is generally supposed. The reason for the latter is probably too often due to the greater convenience of measuring the diameter of the pipe, to which the contemplated attachment is to be made, rather than measuring the quantity which the pipe can deliver.

The writer believes that there is but one reliable and satisfactory method for practically determining the proper maximum capacity of a meter to be applied to a service, namely, to insert a meter in circuit, open all the valves or faucets and time the operation of the meter for one, five or ten minutes. Thus, if a ¾-in. meter has been set and its full delivery is only, say, 1½ cu. ft. a minute, then in the majority of cases, a ⅝-in. meter would satisfactorily replace it, and so on through the range of sizes.

The proposition has also been previously set up by the writer that in his "belief and judment, the proximate increase of efficiency in water meter practice will come quite as much from the better knowledge and practice of water-works employees as from direct improvements in meters by manufacturers and engineers." And the points just made in regard to the selection of a proper capacity of meter, the one best suited, not to the diameter of the pipe, mayhap, but to the volume which it will be required to deliver, is directly in touch therewith. A new engine is not selected for an old factory by the diameter of the existing main-shaft, but upon an appropriately definite knowledge of the machinery to be driven, and the power necessary therefor. But this illustration ends here; for in the instance of the engine, the required power may be predicted within the range of practical requirements, while in the case of the meter, a formula is yet to be written which will disclose the interior condition of valves, department stop-cocks, and such service pipes as have received the usual supply of plumbers' "trade marks." Hence, the expressed opinion that there is but one reliable plan to follow, at once convenient and eminently practical, namely: to apply the meter, time its delivery, and thereby ascertain its rate of operation. The commercial advantage of closely looking after this feature of meter practice will be almost entirely on the side of the purchasers of meters. In many cases where a meter smaller than the pipe is selected it will have a two-fold advantage, effecting both a reduction in the first cost and an increased sensibility of a smaller instrument.

Regarding the maximum capacities of meters as published by the different meter companies, they in fact mean but little, and are often deceiving and disappointing. It is like saying: Given the requisite head, and the supply, and the conditions, and we will blow as much water through a nozzle of 2 ins. diameter as the other fellow with a nozzle of 1½ ins. diameter, the mental reservation being made, however, that "we" will design and fabricate both of the said nozzles. The table of the greatest proper quantities per minute, promulgated, it is understood, by the late Henry R. Worthington, is probably the nearest to a proper scientific basis—that is, velocity of flow through the pipe—of any known to the writer, as the controlling merit of those tables which have been developed more recently would seem to be in the higher figures employed. But such tables may be taken as representing the very highest rate of operation at which the meter should be operated under extreme conditions—as in increased pressure for fire service—while for any fairly uniform rate of delivery all published maximum rates should be considered as in the case of list prices, subject to discount.

The third general application has reference to the matter of obstruction to the flow, which is often an important one in meter practice, and in this connection it may be well to call attention that the mere exhibition of a meter device operating under a slight head, or by blowing or exhausting, should be understood as simply demonstrating the mechanical resistance of the parts, and is quite independent of the loss of head, which may be due to tortuous water passages, or restricted ports. The complete and ready demonstration in such cases, where it is necessary or desirable to know the extent of the obstruction, is to note the time required to discharge a certain quantity into a trial-tank both with and without the meter in circuit, being careful to observe that all conditions of each test are identical.

In conclusion, a few general observations, not to say predictions, may be admissible.

The day of division in the selection and use of water meters is at hand, if the water-works purveyor would obtain the best economic results; for there is no meter now on the market, nor is there any likelihood of its being devised, which will at one and the same time give equally satisfactory results under all conditions, when measured by the gage of economics. From whence it follows that special services require as fair an exercise of judgment in the selection of the meter to be employed, as in the instance of a pump intended to feed a boiler or to drain a mine.

In a table prepared by the writer in 1891, for the previously mentioned paper, it was shown that the relation of meters to taps in the United States was only slightly over 6%. This was subsequently taken up by Engineering News and, according to present recollection, the relation which it found was about 7%. These figures were obtained from the most reliable source then at hand, and were probably the first compilations of the kind ever made. They will be of particular value, however, should the opportunity again be taken to make a comparison at a yet later date; as it is the belief of the writer that although from 35,000 to 40,000 water meters are now being made and sold every year in the United States, nevertheless the water services are probably being increased at nearly, if not quite, as rapid a rate as the application of meters. Consequently, unless the production of meters shall be increased at even a much greater rate than heretofore it would then be fair to assume that the ratio of meters to taps will not materially change.

But the writer trusts and holds that this relation will not remain constant. He believes that the increasing use of water meters is a public benefit; that the suggestions herein contained, were they but partially carried out, would result even more beneficially; moreover, that such benefits would be mutual, and hence the "game" may be "worth the candle" to us all.

ATTACHMENTS OF M. C. B. COUPLERS.*

Discussing first the form of the rear end of drawbars, the committee recommended two standards, designed for use with either the yoke or the tail-bolt, and one of them being slotted for the equalizer of a continuous draft rigging. Concerning the much discussed question of tail-bolt vs. yoke attachment, the committee received replies from 45 members, representing 620,000 cars. The number of cars represented by those which have adopted each of the three standards is:

Standard.	Yoke.	Tail-bolt.	Continuous.
No. of cars.....	343,196	197,201	72,230

But the superiority of the yoke attachment is shown still better by the fact that among the representatives controlling the 197,201 cars on which the bolt is standard, representatives of 172,153 cars reported to the committee that they considered the tail-bolt the weak point of their draft rigging, and intended to adopt the yoke in its place. Under this showing it is evident that the tail-bolt must go. But while the committee is convinced that the 2-in. tail-bolt at present in general use is much too weak, they did not think it needful to provide for any larger size in the standards which they submitted, believing it better to let the tail-bolt die a natural death. The designs recommended take 1⅛ in. rivets for fastening the yoke to the drawbar, and a 1 × 5 in. equalizer where continuous draft rigging is used.

Concerning the "attachments of drawbars at the rear end," the committee found that the standards of the Association are practically a dead letter, except perhaps the tail-bolt diameter and the thickness of the follower plates. Most of the members, however, are using draft rigging, which is similar to, but an improvement on, the old standard; and the committee therefore designed a standard for drawbar attachments of the same general type as the old, but of more modern design.

The use of buffers with the M. C. B. coupler was discussed at length. The present standards are wholly ignored. Present practice, as ascertained by the committee, is about as follows: Representatives of 98,707 cars report that they are using buffer blocks with M. C. B. couplers, while representatives of 480,009 cars say they are not. But of this latter number, representatives of 132,917 cars say that in their opinion the buffer blocks are of advantage and should be used. Thus the vote by opinions stands 356,089 cars for buffer blocks and 231,624 cars against. The committee discussed at length various arguments for and against the buffers, and reached the following conclusions: (1) The buffers, when properly designed, are of value in relieving the draft rigging from severe shocks. (2) When so designed they will not interfere with coupling on sharp curves. The committee has found no difficulty in making couplings in any position on curves as sharp as 38°, even when draft gears are old and the inner face of the knuckle projects but little over 1 in. from the face of the buffer blocks. (3) The buffer blocks cannot be so designed as to meet all conditions (the M. C. B. coupler meeting all sorts of link and pin bars.) (4) But as eventually all couplings will be made between bars of the M. C. B. type, the buffers should be designed only for M. C. B. couplers meeting M. C. B. couplers. (5) Concerning the need for protection to the draft rigging from the shocks of service, the following statistics and comments were presented, showing the number of cars repaired on one of the railways represented on the committee during one month:

Defects.	No. of cars repaired.
Cast iron buffer blocks	11
Deadwoods	95
Deadwood bolts	75
Drawbar stop castings	205
Drawbar stop casting bolts	436
Drawbar stop casting straps	129
Drawbar stop casting strap bolts	221
Drawbar followers	476
Drawbar springs	472
Drawbar pockets (yokes)	51
Drawbar pockets (yokes), bolts	107
Drawbar rests (carrying irons)	51
Drawbar tail-bolts	217
Drawbar continuous rods	25
Drawbar tail-bolt keys	25
Draft timbers	249
Draft timber bolts	1,008
Drawbars (common)	1,026
Drawbars (M. C. B.)	114
Drawbar knuckles (M. C. B.)	179
Drawbar knuckle pins, etc. (M. C. B.)	39
Total draft gear defects	5,211
All other causes	8,654
Total number of cars repaired during month	**13,865**

These figures show to what extent expenditures and delays are due to defective draft gear. There is certainly some cause here for serious consideration as to the value of double buffer blocks.

We believe that the use of double buffer blocks does not interfere with the practical operation of the M. C. B. coupler. We believe that it would protect the couplers, knuckles and draft gear to a great extent by receiving the heavy buffing blows in the line of the greatest resistance and absorbing their force in the framework of the car, which must eventually receive them under all conditions through the inadequacy of a spring to absorb them. The additional cost of double buffer blocks cannot be above $5 per car over the single deadwood. We are inclined to think that this would be much more than counterbalanced by the saving in repairs, switching and delay to freight.

(6) The possibility of taking up the shock by the bracket on the drawbar coming against a single deadwood was also considered, and the conclusion was

*Abstract of the report of the committee on Attachments of M. C. B. Couplers, presented at the annual convention of the Master Car Builders' Association, at Lakewood, N. Y., June 13.

reached that it was an unsatisfactory method of absorbing buffing blows compared with the use of double dead blocks. (7) Thus, taking into consideration the extent to which double deadblocks are already in use or favored, the committee felt justified in submitting a design for a new standard for double deadblocks. It is similar to the old, but is 1 in. deeper, and the face of the deadblocks on cars of the ordinary type without end platforms is 14¾ ins. from the end of the car instead of 10 ins., as in the old standard.

Taking up the capacity of draft springs, the present standard for which is 18,000 lbs., the committee stated that members representing only 130,019 cars reported the use of springs of the standard capacity, while 394,362 cars were using draft springs of 19,000 to 25,000 lbs. capacity. After showing that a very small part of the blow of a colliding car can be absorbed by the draft spring in any event, and that every increase in the draft spring capacity means increased recoil, the committee recommended that 22,000 lbs. be made the standard capacity.

The committee further called attention to the importance of making drawbars of the standard length, 21¼ ins. from the tail of the real face of the bracket, in order that the coupler might be in correct position with reference to the buffer blocks. In conclusion, a discussion of several of the modern types of draft gear was given, and the opinion was expressed that any recommendation of a standard draft gear in wood construction would be impracticable. In order that the Association's standards might not be too far behind the times, however, a design of a draft gear more in accord with modern ideas than the old standard was proposed for adoption by the Association as "recommended practice." Looking forward a little to the adoption of metal sills, which is bound to come in the near future, it appears likely that when that is done a standard draft rigging simpler and stronger than any now in use can be adopted with good effect and will much simplify the problem now before the car builders.

THE VALUE OF CEMENT LINING IN AN IRRIGATION CANAL.

The Gage Canal, at Riverside, in southern California, is 22 miles long, and is used for irrigating

Cement Lining on the Gagé Irrigation Canal, California.

orange groves, vineyards, etc. This canal has been in use for 12 years. It was found several years ago that a great deal of water escaped by reason of gophers burrowing in under the canal, thereby injuring the canal to such an extent that it was found absolutely necessary to devise some means of preventing the enormous waste of water. It was finally decided to re-grade and cement the whole canal, and the contract for doing this work was awarded to the Gray Bros., of San Francisco and Los Angeles, for about $120,000.

The cement was spread 1½ ins. thick on the banks and mixed one part cement to four parts fine sharp sand. At times more than 300 men were employed on this work, as it only could be done during the rainy season when the water was not wanted for irrigating purposes. The first section of this work has been done now for about two years, and the cement holds perfectly good. Where heavy fills of earth were made, about 8 ins. of masonry were used. It has been found that since this work has been finished the water company has received more than twice the amount of water obtained from the uncemented canal, thus showing that friction, evaporation and loss of water by leakage were more than 50%. This is supposed to be the longest irrigating canal known that is cemented throughout. The half-tone illustration given is from a photograph of a portion of the work sent in by the Gray Bros., and shows the general appearance of the cemented canal.

AN INNOVATION IN VALVE GEARS.

Inventions in locomotive valve gears are always with us, but it is very seldom that any of them prove to be new on thorough examination, and the few which are new are generally found wanting in practical merit. Our attention has just been called to a device, however, which is of interest from its extreme novelty, and which certainly possesses several important advantages over the long standard Stephenson link. Whether it has disadvantages which will offset these remains to be seen.

The new gear is the invention of Mr. David Joy, the inventor of the well known Joy valve gear, which, though it has not found much favor in locomotive work in this country, has been extensively adopted in marine engines. Mr. Joy's new invention is as different as possible from his former one as well as from all other existing types of reversing gear. Briefly described, it consists in the use of a single eccentric attached to the shaft in such a manner that it can be moved into either forward or backward position or any position between them. The eccentric is made with a slot in which slides a square block which is fast on the shaft. Two plungers working in short cylinders govern the position of the block in the slot and thus the position of the eccentric on the shaft; small steel pipes lead from these cylinders to the cab, where a cylinder and piston is so arranged that the engineer can force oil into one cylinder and exhaust it from the other to place the eccentric either full forward or back, or at any intermediate position.

The advantage of this arrangement is, first, its extreme simplicity. Two eccentrics complete, with their rods, and the entire mechanism of links, hangers, blocks and reverse lever and connections are saved on each locomotive. Something is gained also in the more exact motion of the valve, which in the case of an inside cylinder engine is driven directly by the eccentric. On an American engine the eccentric would drive the lower arm of the rocker direct. The saving of the lost motion in the numerous joints of the ordinary link gear is at least no disadvantage. Exactly what distribution of steam would be effected by the device it would not be possible to say without constructing the diagrams. Our contemporary, "The Engineer" states, however, that the distribution is almost perfect for both ends of the cylinder.

For the liquid to convey the pressure from the piston in the cab to the plungers on the eccentrics a thick oil is used which prevents corrosion and has little or no leakage. In case of any excessive leakage past the piston or plungers the eccentric will at once move to full forward or back position, whichever side of the center it may happen to be, and the engine will, of course, be controlled then by the throttle. On the trial trip of the first locomotive fitted with the gear this accident occurred through the leaking of an imperfectly fitted piston leather; but the train was brought home without difficulty.

In ordinary reversing of the locomotive the piston is worked by hand, but to arrange for the quickest possible reversing in emergencies the piston rod of the oil cylinder in the cab is attached to the piston of a small cylinder worked by compressed air from the brake reservoir. A difficult detail of the apparatus is the connection of the piping to the plunger chambers in the eccentric. This has thus far been done by boring a small hole along the center of the axle, the hole from one end leading to one cylinder and that from the other end to the other. One would imagine that the pipe connections to the ends of the axle might be troublesome to keep tight, and boring the center of a locomotive axle is not an especially easy job.

The London, Brighton & South Coast Ry., in England, fitted an engine with this gear several months ago and is now applying it to a second engine.

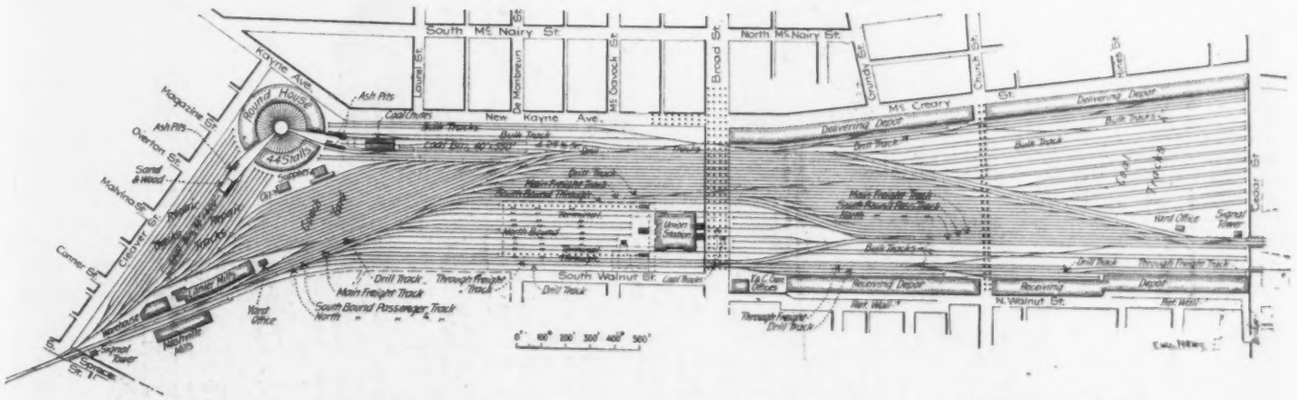


FIG. 1. PLAN OF TRACKS AT NEW TERMINAL OF THE LOUISVILLE & NASHVILLE R. R., NASHVILLE TENN.

THE LOUISVILLE & NASHVILLE R. R. CO.'S NEW TERMINAL YARDS AND STATION AT NASHVILLE, TENN.

The Louisville & Nashville R. R. Co. has prepared plans and will soon begin work on extensive improvements to its terminal facilities in the city of Nashville, Tenn. These consist, in brief, in enlarging and extending the company's yards and in constructing a union passenger station fronting on Broad St. to be used by all the railways entering the city. The general plan of the proposed yards is shown in Fig. 1, and a perspective view and plan of the station in Figs. 2 and 3. When these improvements are completed it is thought that the railway terminal facilities at Nashville will surpass those of any other city south of the Ohio River.

The general arrangement of the yards is shown in Fig. 1. They cover an area of 70 acres, and, in addition to the various tracks, provide for a roundhouse, separate depots for receiving and delivering freight, the new passenger station, coal pockets, and the usual minor buildings necessary to fully equipped terminal yards. There will be no grade crossings, the tracks being crossed either overhead or underneath in all cases. As will be seen, two of these viaducts, at Church and Broad Sts., will be of considerable size.

The passenger station will be centrally located and will front on Broad St., the main avenue of the city, which is 100 ft. wide. The track level is 22 ft. 5 ins. below the street level. The plan is so arranged that the building will be a through station, the tracks passing alongside and under it. At the street level will be the general waiting-room, lunchroom, ladies' waiting-room, colored waiting-room, ticket, Pullman and other minor offices, lavatories and elevators. The street in front at this level is carried on a viaduct 955 ft. long, the full width of Broad St. This viaduct will be constructed with broad sidewalks and have electric car lines running in both directions over it.

A handsome porch extends from the street to the front of the building. The main waiting-room is 120 ft. long, 51 ft. wide and 72 ft. high, with a dome ceiling of stained glass. The three floors above the main floor flank this waiting-room, and will be utilized for offices of the various companies entering the city.

The building will be stone, with slate roof, and have a clock tower on the north front, and another tower on the south front, which will be utilized for elevators and ventilating shafts, smokestack, etc.

The interior will be finished in Southern yellow pine, except the main waiting-room, which will be finished in oak. All the walls and ceilings of the rooms will be highly frescoed, and the rooms will have marble wainscoting and tile floors. The heating and ventilating will be the fan system. The plants for these, as well as for the electric lights, will be placed in the basement on the track level. The baggage, mail and express rooms are placed on Walnut St. on the east side facing the train-shed, having elevators running down to the platform level. The shed will be 600 ft. long and 232 ft. wide, constructed of iron with slate roof.

FIG. 2. PROPOSED NEW PASSENGER STATION OF THE LOUISVILLE & NASHVILLE R. R., AT NASHVILLE, TENN.

The plans for the station were prepared in the office of the chief engineer of the Louisville & Nashville R. R., by Mr. F. W. Mowbray, Architect. The plans of the other terminals were prepared by the company's engineers under the direction of Mr. Richard Montfort, M. Am. Soc. C. E., Chief Engineer. We are indebted to Mr. Montfort for the matter from which our illustrations have been prepared.

ANNUAL REPORT OF THE STREET DEPARTMENT FOR 1892.

The annual report of Mr. Henry H. Carter, the superintendent of streets, of Boston, Mass., contains some excellent material relating to the streets, sewers, etc., of that city. This report deals more largely with detailed information than is usual with public documents of this kind, and some of the information is here abstracted:

Boston has an aggregate of 443.3 miles of streets paved as follows: Asphalt, 6 miles, or 100,812 sq. yds.; block, 74.8 miles, or 1,615,925 sq. yds.; brick, 0.36 mile, or 3,638 sq. yds.; cobble, 4.6 miles, or 57,321 sq. yds.; telford and macadam, 208.7 miles, or 3,820,830 sq. yds.; gravel, 137.2 miles, or 2,264,955 sq. yds., and not graded, 11.7 miles, or 220,217 sq. yds. The aggregate area is 8,083,708 sq. yds. Mr. Carter presents an interesting comparative table of kinds and amount of pavement used in various large cities, in percentages of area paved, as follows:

	Washington.	St. Louis.	Chicago.	Buffalo.	New York.	Philadelphia.	Boston.
	Percentages.						
Sheet asphalt	43.90	1.17	1.40	33.12	8.52	5	1.20
Coal tar	15.74	.....	.....	.....	.....	.....	.....
Asphalt block	7.56	.....	.40	.....	.65	2	.16
Block stone	15.82	28.95	2.79	34.60	75.27	20	16.87
Wood	.....	1.86	63.13	.....	.....	.....	.....
Cobble	8.98	.....	.....	.....	.30	42	1.03
Vitrified brick	.....	.....	.07	.40	.01	5	.08
Rubble	.....	.....	.....	.....	.....	14	.....
Telford	.....	7.48	.....	.36	.....	.....	9.92
Macadam	8	59.64	32.19	31.62	15.95	12	37.16
Gravel	.....	.....	.....	.....	.....	.....	33.58
Burnt clay	.....	.....	Tr.	.....	.....	.....	.....
Mileage	165	450	578.7	379.5	441.54	819.8	443.30

This table explains why the cost of street maintenance differs so widely in the cities named. For example, Buffalo has nearly 30 times as much sheet asphalt as Boston, with a lower mileage of streets. Nearly 81% of the Boston streets are either macadamized or graveled, and Mr. Carter believes it would be in the direct line of economy to substitute for this a more permanent form of roadway. The report favors asphalt as making an admirable pavement; but brick pavement laid in 1891 shows a marked tendency to chip at the joints and no more has been put down.

In all contract work on streets the city of Boston furnishes all material, except paving gravel, and this is provided by the contractor and the price is included in the bid. This material is in most cases delivered to the contractor on wharves or at

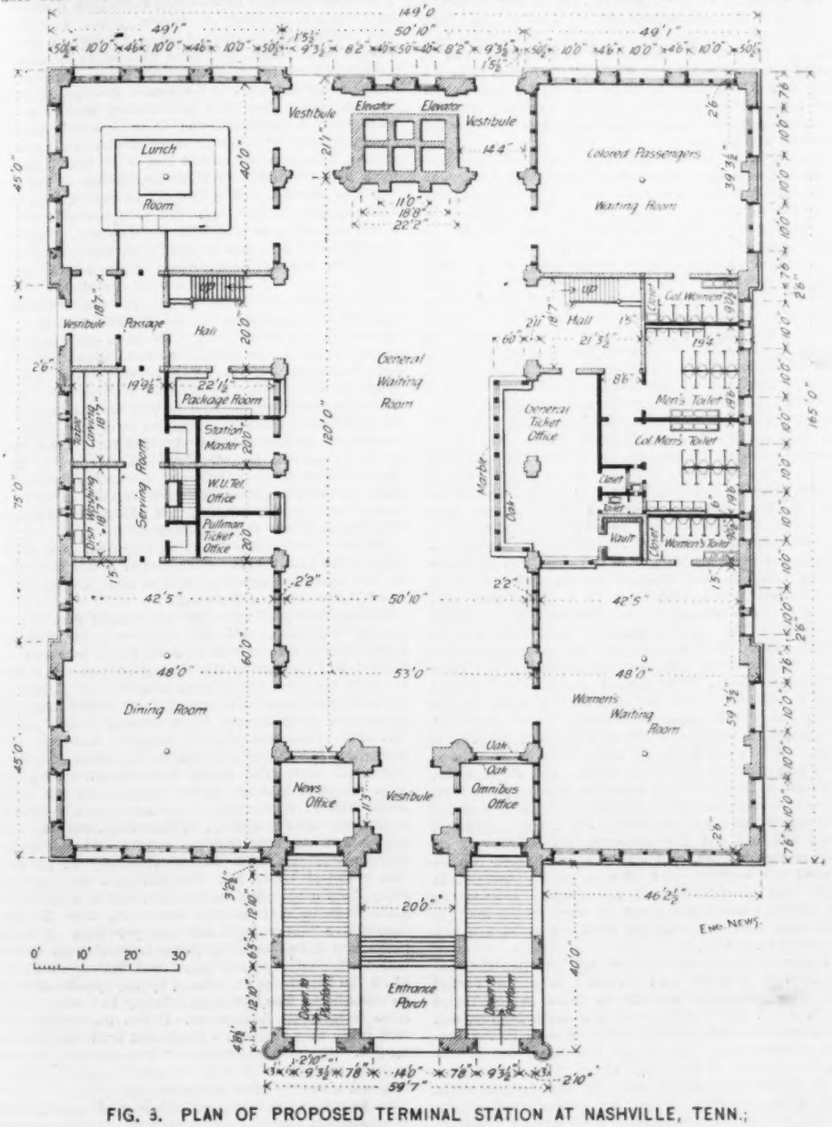


FIG. 3. PLAN OF PROPOSED TERMINAL STATION AT NASHVILLE, TENN.; LOUISVILLE & NASHVILLE R. R.

city yards. The 5.97 miles of streets paved in 1892 cost, exclusive of material and labor furnished by the city, as follows for the types named: Block paving on gravel base with gravel joints, an average of $3.10 per sq. yd.; block paving on concrete base with pitched joints, $4.75; Sicilian rock asphalt paving on Portland concrete base, $3.60; Trinidad asphalt on concrete base, $3.60; on old cobble base, $2.25; new flagging laid, $5 per sq. yd.; block asphalt on a sand base, $3.60. The new specifications for granite blocks call for a depth ranging from 9 to 14 ins., with an average of 11½ ins.; the old specifications called for blocks 8 to 12 ins. long, with an average of 10 ins. As showing the relative cost of contractor's work and material and labor furnished by the city of Boston, it is stated that the 5.97 miles of streets paved in 1892 cost $193,595.85 paid to contractors, and the total cost to the city, including materials and labor, was $435,160.20.

Under the head of the removal of house offal and house and store dirt, a table is given, showing that the amount of this removal has increased from 27,408 loads in 1883 to 46,343 loads in 1892; each load being equivalent to 57 cu. ft. and weighing 1½ tons. This table does not include about 5,100 loads per year removed from East Boston and Brighton. This material is practically collected by 101 offal carts and 191 men, all but 8 carts and 16 men belonging to the city force. The disposal of this offal is one of the most serious problems with which the city is confronted. Of the total 46,343 loads removed 30,773 loads were sold to farmers for $21,282.82, and 15,570 were dumped at sea or wasted. As the offal bought by farmers was fed to pigs afterward sold in the city, the late agitation against this practice has resulted in the decreased sale of about 10,000 loads in the last year. It is expected that within two years the selling of offal for food purposes will be entirely prohibited by the boards of health of the many suburban towns. Towing it to sea is unobjectionable except in the expense of hauling to the dump scows from remote sections. The report then proceeds to discuss and describe the Simonin process of treatment by chemicals and the Engle process of cremation, with copies of the propositions made by these companies to Boston. The Merz chemical reduction process and the Brown crematory are also described. For the Simonin process the city would have to invest about $175,000 in plant and an annual outlay of about $10,000; the owners of the process would pay for the privilege of disposing of the manufactured product. For a cremation plant the cost would be about $80,000, and the city would have to run it at an estimated cost of 75 cts. per ton destroyed, or $60,000 annually. Mr. Carter recommends that all offal within reach of the scows be taken to sea and dumped, and that two chemical treatment plants be erected at convenient centers named.

The amount of ashes removed has increased from 159,197 loads of 43 cu. ft. in 1882, to 303,878 loads in 1892. Of this total 299,678 loads were deposited on low land and the remainder towed to sea. The amount of street sweepings has increased from 52,381 cart loads in 1882 to 106,829 cart loads in 1892. The superintendent says that the condition of the streets in regard to cleanliness is far from satisfactory, and he charges this chiefly to the continued violation of ordinances prohibiting the throwing of rubbish into the streets. The portion of the report relating to the city sewerage is extended, but is in a form that is useless for abstract in the space available for this article.

SOCIETY PROCEEDINGS.

(Continued from page 585).

NEW ENGLAND WATER-WORKS ASSOCIATION.—In answer to a question from Mr. French, Mr. Herschel stated that the nine large gates on the pipe line were made by the Eddy Valve Co., of Troy, N. Y.

As Prof. Thos. M. Drown could not be present, his paper on "The Purification of Water by Freezing" was read by Mr. F. P. Stearns, M. Am. Soc. C. E. President Chace remarked at the close of this paper that pure ice is as important as pure water, and that there is little use of trying to supply pure water unless pure ice is also furnished. An abstract of Professor Drown's paper will be given in a later issue.

A discussion on pipe castings and coatings was opened by Mr. Dexter Brackett, M. Am. Soc. C. E., who read a brief paper on "Uniformity in Designs for Special Castings," which, with illustrations and tables relating to the Boston standards, is given elsewhere in this issue.

Bell up or bell down was the principal question discussed in this connection. The opinion of Messrs. Noyes, Allen and Fuller was that the bell should be down.

A topical discussion on the stoppages of service pipes came next. Mr. Noyes stated that in 1876 the engineer in charge of the Newton works made careful experiments with different kinds of service pipes, and concluded that a tar-coated wrought iron gave good results, which was used. These services filled rapidly. Enameled pipe has since been satisfactorily used, but galvanized iron and lead are now put in, the consumer choosing between the two.

Mr. Fuller had found tar-coated services unsatisfactory; he said that a few galvanized iron services had shown rust, and that for the past few years cement-lined wrought iron pipe had been used. He thought that the lead-lined pipe recently put on the market might prove good.

Mr. Chace stated that in Taunton there had been trouble with the obstructions in cement-lined services, generally at the corporation cock or other connections. Sedimentation sometimes occurred. He thought the character of the water had much to do with the question, and cited trouble caused by crenothrix.

Mr. Brown said that with 800 or 900 cement-lined services at Fitchburg from 10 to 12 stoppages a year occurred. The pipe stands freezing very well.

At Middleborough, Mr. Beals stated, an enameled iron pipe had flaked, the flakes gone forward and caused a stoppage. For large services cement-lined pipe is now used with good results.

Mr. Chace stated that the brown surface water now supplied in Taunton contains tannic acid, which affects the pipe. Enameled iron pipe had been used and filled after one or two years. A change to galvanized iron resulted well. Trouble arises at fresh cut ends of pipe and where corporation cocks do not extend clear through pipes, consequently the latter are now carried ⅓ in. into the pipe.

The principal feature of Thursday evening's meeting was a paper by Mr. F. W. Dean, on "Recent Developments in Pumping Machinery," which was illustrated by nearly 30 stereopticon views of modern pumping machinery, both details and engines in service. Aside from his paper, which we hope to abstract in a later issue, Mr. Dean stated that the Morris engine at Lowell is now being remodeled to work with 160 lbs. of

steam, which is novel as being the pressure generally used with three cylinders, instead of with two, as will be the case here.

The following new members were elected during the convention: Resident active: Geo. E. Crowell, Brattleborough, Vt.; Andrew B. Goodin, Southbridge, Mass.; Horace Kingman, Brockton, Mass.; W. J. Luther, Attleborough, Mass.; Geo. L. Mirick, Everett, Mass.; Joseph E. Selfe, Wellesley Hills, Mass.; F. J. Shepard, Derry, N. H.; John C. Sullivan, Holyoke, Mass.; Frank L. Northrup and J. L. Kennedy. Non-resident active: E. A. Eardley, Pacific Grove, Cal.; Wm. E. Griffith, Cumberland, Md.; R. S. Lea, McGill University, Montreal, P. Q.; Fred. H. Pickles, Winona, Minn.; Wm. B. Tabb, Glens Falls, N. Y.; W. G. Zick, Waterford, N. Y.; A. Prescott Folwell, Atlantic Highlands, N. J.; Associate members: Neptune Meter Co., New York; Benj. C. Smith, Agent for French's Pipe Cutting Machine, New York; Weir Meter Co., Salem, Mass.

Thursday afternoon, through the courtesy of the officials of the Worcester water-works, a drive was taken through Elm and Institute parks and about the city, visits being made to the laboratories and workshops of the Worcester Polytechnic Institute, the works of the Union Meter Co., where refreshments were served, the wire works of the Washburne & Moen Co., and the chemical precipitation works for the purification of the sewage of the city of Worcester. The latter works were described in Engineering News of Nov. 15, 1890, and July 28, 1892, and are now being enlarged as outlined on the latter date. When the improvements now under way are completed the lime will be mixed and agitated by means of compressed air and the sludge will be lifted from the new sludge well by means of a Shone pneumatic injector, the compressed air for the injector being developed from a separate plant with power derived from a turbine driven by the sewage effluent from the precipitating tanks.

At the Worcester Polytechnic Institute the students in mechanical engineering were seen at work in the Washburne machine shop, where hydraulic elevators and twist drill grinders are manufactured for sale, the shop being run on a commercial basis with a regular force of machinists, and the students working a certain number of hours per week as a part of their course, without compensation, and doing some very good work.

At the Washburne & Moen works wire was seen in all its various stages of manufacture. The company has two immense shops and its employees run into the thousands.

At the Union Meter Co.'s works meters were seen in course of construction from 12 ins. in size down.

In returning to the city an exhibition was given by the city fire department in the city hall park, consisting of eight streams from two four-way hydrants on the high service. The afternoon sun and the hose jets joined forces and produced a fine rainbow, with the green of the park as a background, making an appropriate ending to a very enjoyable afternoon.

On Friday an all-day excursion to and on Lake Quinsigamond was given by the Union Meter Co.

An account of the exhibits, which were very good this year, is given in another column under Industrial Notes.

About 165 members and guests were present at the convention.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—The twenty-sixth annual convention opened on June 19, at Lakewood, N. J.; 97 members responded to the roll call at the first session. President John Hickey, Superintendent of Motive Power of the Northern Pacific, in addressing the convention, referred especially to the importance of the labor problem, and counseled moderation and fairness in considering the requests of employees. Many arbitrary demands from employees might have been avoided had courtesy and fairness been used in the treatment of employees in all cases. The ambition of workmen to better their condition is a legitimate and honorable one, and should be recognized, in so far as business conditions permit. Inasmuch as the labor employed by the railways has an influence quite out of proportion to its numbers, it is the more important that differences between employers and workmen in this field should be avoided, so far as possible.

The importance of economy in the master mechanic's department is seen by the fact that locomotive expenses per locomotive-mile average from 22 to 25 cts., nearly half of which is for fuel. The present consumption of fuel due to the excessive use of steam, ought to be reduced, and boilers of larger capacity, enabling steam to be generated with softer blast and less loss by back pressure, are among the means to this end. Compounding is also being tried on a large scale, and on the whole, with apparently beneficial results. The cost of repairs, however, should not be lost sight of, and saving due to the use of the compound principle should not be exaggerated by comparison with badly designed and wasteful locomotives of the ordinary type. A direction in which large economy is possible is in repairs, which now, on some of our largest roads, average nearly 4¾ cts. per mile. A chief item in this is the repairs to fireboxes; hence improvements in the quality of firebox plate, and in the design of the firebox end is important. Three directions in which improvement can be made are in the increased bearing surface of rubbing parts, the elimination of keys and bolts from connecting rod ends, enlarged crank pins, and piecework in place of time work in shops.

It was also suggested that engine capacity should be based on tonnage of train instead of number of cars; to do this, however, a cheap and convenient dynamometer is needed for locomotive use. A permanent advisory, or arbitration committee, to which disputes between buyers and sellers of rolling stock could be referred, was also proposed.

The secretary's report showed that 53 new members had joined the Association and 13 members had died during the year, making the present membership 547. The receipts of the Association were $2,747, and it closes the year with all debts paid and $154.28 in its treasury. Three sons of members of the Association are now taking advantage of the Stevens Institute scholarships and a fourth scholarship is available when any one applies for it.

Messrs. J. H. Lauder and John Mackenzie were appointed a committee to meet the American Society of Railroad Superintendents at their fall meeting, in response to invitation. The matter of adoption of a standard size for the annual reports was referred to the Executive Committee. On further business being disposed of the reports of committees were called for, but none were taken up for discussion until the noon hour, when questions proposed by members were called for. Mr. J. Davis Barnett, of the Grand Trunk, brought up the question as to the relative merits of forging and milling in making side rods of I-section. The discussion which followed was participated in by Messrs. Vauclain, of the Baldwin Locomotive Works; Setchel, of the Pittsburg Locomotive Works; Wm. Forsyth, F. W. Dean, L. R. Pomeroy, A. E. Mitchell, W. H. Lewis Wm. Smith and others. The facts brought out may be summed up as follows: A forged rod is not claimed by any one to be better than a milled rod; the old idea that the skin of a forging is the strongest part is now pretty well exploded; the reason for forging rods instead of milling them is, as a rule, the matter of expense. A forged rod is cheaper than a machined rod in shops where heavy machine tools are not available to do the work rapidly and well. But in a large and well equipped establishment milling machines will turn out fluted rods 25% to 35% cheaper than they can be forged. These figures were not offhand guesses, but were the result of careful investigation by the large locomotive works. The modern tendency is to substitute machine work for blacksmith work. Seven years ago the Baldwin Locomotive Works built ten locomotives a week, and had four acres of blacksmith shops. Now they build 20 locomotives a week and have two acres of blacksmith shops. The shops which are forging their rods are generally making them from scrap iron, although some use steel. To do a nice job two sets of dies are necessary, one for the roughing work and one for the finishing. This, however, increases the expense, and a skillful blacksmith can do a good job with one set of dies. This, however, is really one disadvantage of the forging process, as the shop becomes dependent on one skilled man to make side rods, whereas any good machinist can run the milling machine.

It appears to be the general opinion that the machined rod is safer and stronger than the forged rod. The machining will detect flaws in the metal which would not be discovered in a rough forging, and the machining also removes initial strains in the surface of the metal. In a bright rod in service, cracks can be observed at the start, which could not be seen on a forged and painted rod. On any forging made with a square corner little "fire cracks" will be observed, and in steel rods these are likely to gradually work their way into the rod and cause its failure. In this connection, Mr. J. H. Setchel advocated the turning of locomotive tires before use as a measure of safety. Mr. F. W. Dean alluded to the great advance in the speed of milling machinery recently made by the Pratt & Whitney Co. in causing the milling cutter to work with the movement of the piece instead of against it.

Following this Mr. T. W. Gentry brought up the matter of breakages of cylinders and frames on consolidation locomotives, due to cylinders getting loose. In the discussion on this topic it developed that a considerable number of the members had had breakages of this class. The causes assigned were too thin walls in the cylinder casting, poorly fitted bolts and carelessly adjusted keys holding the cylinder and frames together, high speed of small wheel consolidations making counterbalance insufficient, increased sizes of boilers and cylinders, separating their centers farther from each other. The remedies named were, as temporary measures, to put cross-braces on front and back, and as permanent remedies to increase the thickness of the walls in cylinder castings and secure good fitting on bolts and keys.

This was followed by a discussion on piston rod breakages. These were generally ascribed to too infrequent taking up of the wear of the cross-head, causing it to rock on the guides. This evil is especially great with the Laird guide. Mr. Smart, of the Michigan Central, had increased the length of his crosshead from 18 ins. to 23 ins., and had stopped the breakages thus. The use of a taper instead of a square shoulder where the rod joins the piston was also mentioned. Frequent inspection appeared to be the practice for preventing accidents, and it was stated that rods would not run over 10 or 12 months before cracks would form.

Tests of Iron and Steel.—This committee devoted its investigations chiefly to firebox steel, and examined specimens which had been in service from 6 months to 18 years. The tests were made by notching a piece of 7 × 3 ins. to a width of 1½ ins. at the center and bending it back and forth until fracture occurred. In some cases the piece was nicked slightly at the point of reduced width, and these samples showed a fracture from which more could be learned than the others. The steel not nicked had to be bent back and forth so many times that the appearance of the fracture was affected, and little could be judged from it as to the quality of the steel. The same thing is true of a fracture made in a tensile test machine. The fracture made by a nicked bending test, however, gives a very clear idea of the character of the crystallization, and frequently of the amount of lamination in the piece. Nearly every piece subjected to this test showed more or less lamination, the gas bubbles causing it appearing to be from ⅛ in. wide to a size extending nearly across the fracture. The steel which had given longest service showed decidedly the fewest laminations, though a slight lamination was observed here. The committee was inclined to believe that an idea of the durability of firebox steel can be gained from the amount of lamination observed; but it was not quite ready to take a decided stand on this point. They were, however, convinced that the present specifications for firebox plates, which refer only to chemical composition, tensile strength and elongation, were not sufficient to insure satisfactory results.

The last part of the report was devoted to a discussion of the idea that a better way to select steel than by the usual specifications was to have an expert inspect the fracture of the steel.

Diamonds, wheat and silks are bought and sold on expert inspection, said the committee, so why not steel? Boiler makers can now be found who can tell a good deal concerning the quality of a piece of steel from its fracture, and if such a man were to educate himself by a systematic study of all sheets taken out of service, his judgment might become almost infallible. The committee did not propose, however, that present chemical and physical specifications should be dispensed with. The report was signed by Messrs. Wm. Smith, J. N. Barr, A. W. Quackenbush and P. H. Peck. Mr. D. L. Barnes, of the committee, submitted a minority report, stating, in substance, that he took no stock in the idea that the opinion of boiler maker experts was preferable to the testimony of physical and chemical tests. Mr. Vauclain said that to turn away from a scientific specification and test for boiler plate was to take a step backward. The Baldwin Locomotive Works buys 150 tons per week of boiler plate, and it has been for years improving its specification at every possible point and taking advantage of all the knowledge introduced by the specifications of its customers. The principal difficulty in testing sheets is to discover the lamination. Unless the cavities are very gross they cannot be discovered until the sheet is flanged. He was thoroughly of the opinion that the way to get good steel was to make a good specification and make the steel maker live up to it.

So the discussion continued, bringing out a great deal of experience, valuable and otherwise. It appears that the failures of fireboxes, of which many are complaining, are failures from cracks and not from blisters. The cause of these cracks is probably washing out boilers having firebrick arches with cold water. It does not always insure their being washed with hot water if the master mechanic gives orders to that effect. Roundhouse foremen do not often realize that water to be suitable for washing hot boilers should not be merely warm, but should be hot. The design of the firebox and the treatment of the steel in the shop may also have considerable to do with the cracking. Again, the laminations, if deep in the plate, will cause a crack instead of a blister. Cracks are due to overheating of the plate; and laminations cause overheating by obstructing the flow of heat to the water.

The nicked bending test is the best method of detecting laminations thus far devised, but of course taking the test piece from a large plate is testing at random; there is no assurance that the laminations

may not exist in some other part of the plate. At Leeds, England, it is said that the mill inspector watches for black spots on the sheets as it cools after rolling, these denoting the presence of a lamination beneath. Apparently this is only for the detection of very large cavities, however. The steel maker can prevent lamination by care in the treatment, and by using only the bottom part of the ingot for firebox sheets. Steel makers and locomotive builders have confidence enough in the reliability of steel to be willing to guarantee firebox plates for five years service without blistering. Locomotives built under such a guarantee are now running; and steel makers have even agreed to bear the entire expense of renewing the firebox if the steel failed inside of five years.

In the discussion the old controversy as to whether the results of physical and chemical tests were more to be relied on than a manufacturer's reputation was renewed, and those who wanted the master mechanic to rely on the tender mercies of the manufacturer and pay him such a price as he chose to charge were downed in handsome shape. Mr. Vauclain said the claim that manufacturers could not afford to make the best firebox steel for less than 4 to 6 cts. per lb. was nonsense. The very best firebox steel possible to produce can be made at a profit to-day at the ordinary market prices. Wm. Forsyth said that the safety of relying on a manufacturer's reputation for the quality of steel was well shown by a recent experience on the Chicago, Burlington & Quincy. Some steel from makers of the highest reputation was found too high in sulphur to meet the specification. The seller at first claimed the analysis was faulty; but afterward acknowledged that an investigation showed that sulphury gas had been in use and had contaminated the metal unknown to the manufacturer.

Thus the advocates of the engineer's method of procedure came off with flying colors, and their opponents, while doubtless "convinced against their will," had few facts to support their views.

Tuesday.—The report on "Compound Locomotives" was this year, as last, the most important one presented. The committee has not continued the extended scientific tests which were reported last year, but has collected from the various railways having compound locomotives in use a record of their experience with them. The increase in the use of compound locomotives during the past year has been remarkable, and we shall give further particulars of this report in a later issue. In the discussion, it was shown that these engines are thoroughly satisfactory in freight service, but there was some disagreement as to their fuel economy over simple engines in fast passenger service. It was conclusively shown that the charge made that increased repairs would cause a loss of service in the compound engine is unfounded. Following this report, Mr. Samson Fox, of Leeds, England, was invited to address the convention on tests of firebox steel, and his remarks we shall notice later.

The committee on "Standard Diameters for Wheel Centers and Tires" reported that standard diameters of tires above the present standard sizes should be 70, 74, 78, 82, 86 and 90 ins. A standard section for both plain and flanged tires of various widths and thicknesses was also reported, and its general adoption was strongly urged by the committee. If this were done, the tire maker, on account of his entire stock being rolled to one contour, could carry a much smaller stock and still be able to meet all demands, and would have fewer rolls to maintain. He would thus be able to keep his rolls in better order and to finish the tires so accurately that machining in the shop would not be necessary. The user of tires, on the other hand, would always be able to have his orders promptly filled and could carry a smaller stock and save interest on its cost.

The report was accepted and the sizes recommended were adopted as standards. The session then adjourned and the afternoon was spent in an excursion to the Brooks Locomotive Works, at Dunkirk.

At the closing session on Wednesday, the old officers were re-elected, as follows: President, John Hickey, St. Paul, Minn.; First Vice-President, William Garstang, Richmond, Va.; Second Vice-President, R. O. Blackall, Albany, N. Y.; Secretary, Angus Sinclair, New York; Treasurer, O. Stewart, Charleston, Mass.

ENGINEERS' CLUB OF CINCINNATI.—At a recent meeting "Underdrainage as a Structural Feature in Engineering Construction" was the subject of a paper read by Col. Latham Anderson. It treated of the underdrainage of earthwork embankments as a means of promoting their strength and durability as engineering structures, the object of the drainage being to protect the embankment from sliding or washing from the action or presence of water, either by excluding it entirely or by leading away such as might or had accumulated.

ASSOCIATION OF ENGINEERS OF VIRGINIA.—The summer meeting will be held on June 30 and July 1, at Hotel Rockledge, on Mill Mountain, 2½ miles from Roanoke. L. J. Carmalt, Secy.

COMING TECHNICAL MEETINGS.

CANADIAN SOCIETY OF CIVIL ENGINEERS,
June 28. Secy., C. H. McLeod, Montreal, P. Q.
DENVER SOCIETY OF CIVIL ENGINEERS,
June 27. Secy., F. E. King, Jacobson Bl'k.
ASSOCIATION OF ENGINEERS OF VIRGINIA,
June 30, July 1. Secy., L. V. Carmalt, Roanoke, Va.
ENGINEERS' CLUB OF PHILADELPHIA,
July 1. 1122 Girard St. Secy., L. F. Rondinella.
SWEDISH ENGINEERS' CLUB,
July 1. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
ENGINEERS' CLUB OF ST. LOUIS,
July 5. Secy., Arthur Thacher, Odd Fellows' Building.
WESTERN SOCIETY OF ENGINEERS,
July 5. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

BALTIMORE & CUMBERLAND.—A corps of engineers, in charge of Alex. Murdoch, started from Hancock, Md., June 8, on the first survey toward Hagerstown, Md. It is reported that the survey between Cumberland and Hancock is completed and the estimates nearly finished.

BANGOR & AROOSTOOK.—A. A. Burleigh, president of this road, is reported as stating that the line will be completed between Brownville and Houlton, Me., 94 miles, by October of this year. About 1,500 men are at work near Brownville, and this number will soon be increased. The line has also been surveyed to Caribou, 60 miles north of Houlton.

CATSKILL & TANNERSVILLE.—The track on this road has been laid from Kaaterskill, N. Y., to beyond North Lake, and the road is expected to be ready for traffic next month.

COMMERCIAL ENTERPRISE CO.—This company has been incorporated in New York to construct railways, aqueducts, wharves, etc.; capital stock, $25,000; Wm. Bouldin, East Orange, N. J.; R. E. Masterson, Nyack; Chas. Wendell, Brooklyn.

MONTREAL & WESTERN.—It is reported that this road will be extended to connect with the Ottawa & Gatineau Valley Ry. at Le Desert, Que. It is now in operation between St. Therese and St. Agathe, 44 miles, and will soon be completed to St. Jansin.

NORTHERN CENTRAL.—L. B. McCabe & Bros. and P. Reddington, of Baltimore, have been awarded the contract for grading about 11 miles of second track on this road, between Falls Yard and New Cumberland, Pa. There will be an iron girder bridge at Goldsboro, two 40-ft. deck spans, and one at New Cumberland, two 73-ft. half-through spans. The masonry, bridge erection and tracklaying will be done by the company.

OHIO SOUTHERN.—It is reported that this road and the Pennsylvania R. R. are preparing to construct a belt line at Springfield, O., to connect the two roads. —The extension to Lima, referred to last week, is expected to be completed next month.

OTTAWA, ARNPRIOR & PARRY SOUND.—This road in Ontario is completed ready for tracklaying, between Ottawa and Arnprior, 35 miles, and construction is being pushed between that city and Eganville, through Renfrew.

OTTAWA & GATINEAU VALLEY—This road, according to press reports from Ottawa, will be completed this summer to Pickanock. About 200 men are at work ballasting the fifth and part of the sixth section, beyond Kazabazua, Que., the present terminus of the road. The iron bridge has been completed, and repair shops erected at Kazabazua.

PITTSBURG, AKRON & WESTERN.—The right of way for the extension between Akron, O., and Newcastle, Pa., 70 miles, has been nearly all secured, and between 15 and 20 miles completed from Akron east.

WABASH.—It is reported that this road has secured franchises and right of way for an entrance into Pittsburg, Pa., from Steubenville, O., and thence north to the lakes. The scheme is described in a press report as follows: Coming from Steubenville over the line of the old State Line Road to the head of Peters Creek the new line will follow the creek over the First and Second Pool road to the Carnegie terminals and Carter charter to Homestead, Pa. Joining the Monongahela connecting road, at Jones & Laughlins, it will cross to the north side of the river, which will enable them in connection with a recently secured charter to reach the business heart of Pittsburg. From the Carnegie terminals on the south of the Monongahela the lake route will cross the Carnegie bridge between Homestead and Braddock, tunnel the hill to Swissvale, follow Negley's Run to the Allegheny, cross the river to Squaw Run, and so join the terminus of the Pittsburg, Shenango & Lake Erie road at Butler. At Conneaut, O., terminals and dockage are now being built.

Projects and Surveys.

RACKET RIVER RY. CO.—Incorporated in New York to construct a road, about 20 miles in length, to be operated by steam or electric power, from Potsdam through Pierport to the village of Colton, with a branch at or near Hannawa Falls to Parishville, in St. Lawrence Co.; capital stock, $250,000; directors include, W. Wickham Smith, Geo. R. Crossley, Brooklyn; Russell L. Kinsay, Buffalo; Frank E. Bennett, Topeka, Kan.; J. L. Ludwig, A. R. Dodge, New York.

SOUTH MOUNTAIN.—It is reported that the greater part of the roadbed for this road has been completed between Bernville and Grantville, Pa., and that work will soon be commenced on the section between Reading and Bernville.

YOUNGSTOWN & OHIO RIVER.—Incorporated in Ohio to build a railway from near Hubbard, on the state line, through Trumbull, Mahoning and Columbiana counties to the Ohio River, at East Liverpool, all in Ohio. Pres., C. H. Smith; Secy., R. W. Taylor; Treas., K. E. Barringer. The survey of the line has been made and the line will be commenced at Hubbard and constructed to Mill Rock, at least, as soon as possible.

Southern.—Existing Roads.

ABBEVILLE SOUTHERN.—The contract for grading and tracklaying between Abbeville, Ala., and the Alabama Midland, near Dothan, Ala., a distance of about 27 miles, has been awarded to S. G. Pruitt, Montgomery, Ala., and work will be commenced at once. Col. B. Dunham, Montgomery, Ala., Gen. Supt. of the Alabama Midland R. R., has been elected chief engineer.

CALDWELL & NORTHERN.—The contracts for building 20 miles of this road has been awarded to Dunavant, Corpening & Miller. Construction has commenced at Lenoir, N. C., and the road is to extend to Caldwell.

FLORIDA CENTRAL & PENINSULAR.—Work on the Savannah extension of this road is being rapidly pushed by the contractors, the Southern Supply Co., Atlanta, Ga. Track has been laid from the southern end to beyond the Georgia state line, about ten miles.

J. T. LIDDLE LUMBER CO.—J. T. Liddle, Handsboro, Miss., Pres., informs us that the company is building a private road eight to ten miles in length, which will probably be open for traffic in two or three months.

MACON & ATLANTIC SHORT LINE.—The stockholders of this road have authorized the directors to construct the road from Bruton to Savannah as soon as possible. The road has already been graded and part of the rails laid between Bruton and Stillmore, a distance of 38 miles. John R. Young, Savannah, is president of the road.

NORFOLK & WESTERN.—The right of way is being secured for a branch of this road from Gilmerton Locks to Portsmouth, Va., a distance of about five miles.

OCONEE & WESTERN.—Rails are being laid on this road within the city limits, at Dublin, Ga., which practically completes the line between Hawkinsville and Dublin.

WAYCROSS AIR LINE.—The city council of St. Mary's, Ga., has granted this company an extension of one year in which to complete the road, provided it is connected with the extension of the Florida Central & Peninsular, noted above, which is to run from Savannah, Ga., to Hart's Road, Fla.

Projects and Surveys.

LIVE OAK, LAURAVILLE & GULF.—It is reported that this road has been surveyed from Live Oak, Fla., to Deadman's Bay, a distance of about 50 miles, and will be built at once, by the Ocala & Blue River Phosphate Co., Live Oak, Fla.

NASHVILLE & VICKSBURG.—This road has been surveyed from Grenada, Miss., on the Illinois Central, to Okolona, Miss., on the Mobile & Ohio R. R., a distance of about 65 miles. W. G. Orr, Okolona, Miss., is interested in securing funds for building the line.

VIRGINIA BEACH.—It is reported that efforts are being made at Norfolk, Va., to organize a company to build a road from the Virginia Beach line, down to the lighthouse, at Cape Henry.

Northwest.—Existing Roads.

BURLINGTON, CEDAR RAPIDS & NORTHERN.—This company has offered to build an extension from Postville, Ia., to the Dolomite quarries, a few miles distant, if the town will raise $5,000 of the $30,000 required. It is reported that the road will be built this summer.

CHICAGO & NORTHWESTERN.—The grading of extension of this road from Ponca, Neb., to Newcastle, Neb., 14 miles, is about completed and it is reported that trains will be running next month.—There is talk of building a line between Cherokee, Ia., and Sutherland, Ia., a distance of 24 miles.

GREAT NORTHERN.—It is reported that tracklaying will soon be commenced on the line from Park Rapids to Leech Lake, Minn., 24 miles in length.

JACKSONVILLE SOUTHEASTERN.—A report from Carlyle, Ill., states that $21,000 of the $25,000 asked to secure the extension of this line has already been secured and that the rest will probably be raised soon.

NORTHERN PACIFIC.—Plans have been prepared for extensive transfer yards at South Superior, Wis. It is reported that this company will have 13 tracks one-half a mile in length, the Great Northern 11 and the Duluth-Superior Transfer Co. 17. The work will be done as soon as possible.

Projects and Surveys.

BAYFIELD HARBOR & GREAT WESTERN.—The contract for clearing the right of way for the first section of this road from Bayfield to Iron River, Wis., 40 miles, has been awarded to John Lambert, as stated last week. It is reported that contracts will soon be awarded for the remainder of the work. Pres., F. W. Dalrymple, Bayfield, Wis.; Engr. E. C. Holidge.

BISMARK & GALVESTON.—Gov. Boise, of Iowa, has appointed 28 delegates to the convention to be held at Lincoln, Neb., June 28, to consider the project of constructing a line of railway from the north line of North Dakota to the Gulf of Mexico. It is estimated that a tax of 5 cts. per acre on the land of the ten states that would be especially benefited would raise the $27,600,000 required to build the road and leave a surplus of $2,000,000. The last legislature of Nebraska urged the importance of such a road. This is the Farmers' Alliance scheme, mentioned some weeks ago, and it is safe to say that it will probably never be carried out.

DUQUOIN & MURPHYSBORO COAL.—Incorporated in Illinois by Walter S. Hawks, F. F. Fallon, Don Onstott, J. C. Monks and H. F. Linzee; capital stock, $50,000.

Southwest.—Existing Roads.

CRESCENT BELT & TERMINAL RY. CO.—Incorporated in Louisiana to build a belt road at New Orleans under a franchise granted to Adolph Schreiber and others; capital stock, $1,000,000; W. J. Behan, H. M. Littell, Otto Elmer, J. B. Sinnott, A. A. Woods and Geo. Lhote.

TEXAS CENTRAL.—Col. Chas. Hamilton, Gen. Man., and Wm. Gould, Engr., have returned from an inspection of the route recently surveyed from Running Water, in Hale Co., through Plainview, Floyd City, Espuela and Ravner, to Albany, Tex. It is reported that the road will soon be constructed.

Projects and Surveys.

DALLAS & FORT WORTH RAPID TRANSIT TERMINAL.—This company, formerly the Dallas & Oak Cliff, has disposed of $500,000 of bonds, and it is reported the projected line between Dallas and Fort Worth, Tex., will be built as soon as possible.

MOBILE, JACKSON & KANSAS CITY.—Judge H. Austil, Mobile, Ala., according to report, is at the head of a company which will complete the 20 miles of this road now graded.

MYRTLE SPRINGS SHORT LINE.—It is stated that the right of way for this road has all been secured, but that no contracts have yet been awarded. Address B. F. Barrett, Myrtle Springs, Tex. Edgar A. Shaver and E. T. Casle, of Pittsfield, Mass., are among the incorporators.

TEXAS.—It is reported that surveys have been commenced for a road to extend from a point on the Rio Grande River to the coalfields near El Paso, Tex. Gilbert N. Marshall, El Paso, is interested.

Rocky Mt. and Pacific.—Existing Roads.

CANADIAN PACIFIC.—Bids were received by Weaver-Bridgeman, Secy. and Treas., at Victoria, B. C., June 7, to construct a road from Nakusp, on Lake Kootenai, B. C., to the Three Forks of Carpenter Creek, a distance of 35 miles, with 15 miles of branches to the Slocan mines. It is reported that the Canadian Pacific is considering a lease of the road, and that if this is done the Canadian government will guarantee the interest on the first mortgage bonds at 4%, and that the road will be constructed at once. According to the Tacoma "News," the legislature of British Columbia has voted aid to three railways for which charters have been granted in the province: The Nicola Valley Co., the Nakusp & Slocan Co. and the Chilliwack Co. The first named has already been granted aid from the Dominion government of $80,000 for the construction of 25 miles of road from near Spence's Bridge toward Nicola Lake, and a further subsidy not exceeding $3,200 a mile on the remainder of its line. The Canadian Pacific has offered to take these three roads, when completed, and operate them 25 years for 60% of the earnings. The British Columbia government has authorized a guaranty of 4% interest for 25 years on bonds not to exceed $25,000 a mile on the Nicola Valley and on the Nakusp & Slocan, and on the Chilliwack bonds the guaranty proposed is 2% on $500,000. The legislature, at its session just closed, passed the acts of incorporation for the following companies: The Red Mountain; Lardeau & Kootenai; Nakusp & Slocan; Osoyoos & Okaogan; Mount Tolmie Park & Cordova Bay; Kaslo & Slocan Tramway Co.; Kootenai, Lake Shore & Lardo; Bedlington & West Kootenai; Nelson & Arrow Lake.

COOS BAY, ROSEBURG & EASTERN.—Geo. Carpy, a delegate from Roseburg, Ore., merchants, has been at San Francisco investigating probable assistance for completing this road to Roseburg (see our issue of last week). It is reported that the $25,000 desired will be subscribed if assurance is given of favorable freight rates.

EVERETT & MONTE CRISTO.—According to press reports tracklaying on this road, in Washington, is progressing at the rate of one-half mile a day and has now reached about ten miles below Silverton, which it is expected to reach this month.

GREAT NORTHERN.—The track on this road has been completed between Seattle, Wash., and St. Paul, Minn., and through train service was commenced June 18. Plans are now being prepared for snowsheds, of which there will be about 4,000 lin. ft. Work on the Everett tunnel is progressing, and it is hoped to have the tunnel completed this fall.

RIO GRANDE SOUTHERN.—It is reported this road will be extended from Durango, Colo., to Phoenix, Ariz. According to the Phoenix "Herald," an extension will leave the line at Mancos, 40 miles west of Durango, pass thorugh Holbrook, Ariz., Globe and Florence to Phoenix.

SAN DIEGO, YUMA & PHOENIX.—The actual grading of the first section of this road has been commenced at Otay Valley, at the terminus of the Coronado Railway, and arrangements have been completed for the immediate construction of ten miles of the road.

SOUTHERN PACIFIC.—This road has secured control of the San Gabriel Rapid Transit line in Southern California, and it is reported will change the remaining portion to standard gage and relay it with heavier rails.

UNION PACIFIC.—Tracklaying has been commenced on an extension of this road from four miles below Catskill, N. Mex., to a lumber camp 2½ miles down the Red River Valley, and it is reported that the line will soon be extended to Raton, 16 miles beyond the lumber camp.

Projects and Surveys.

BURRARD INLET & FRASER VALLEY.—C. D. Rand, of Vancouver, president of this road, is reported as stating that he has completed arrangements for the building of the road, and that it will soon be constructed. It will be 47 miles in length and has been voted a subsidy of $300,000 by the city of Vancouver and of $250,000 by the city of New Westminster. This is the Northern Pacific's extension from Sumas to Vancouver, and it is expected that a deal will soon be arranged with the Great Northern to allow joint trackage from its present terminus at South Westminster over this road.

FLORENCE & CRIPPLE CREEK.—The stockholders of this road have organized the Western Improvement Co.: Pres., Thos. Robinson; Vice-Pres., H. C. Topping; Secy., J. F. Collins; Treas., A. A. Candless.

GOLDEN GATE.—This company, noted last week as incorporated, proposes to build a railway from San Pablo Bay, Sonoma Co., Cal., through the counties of Sonoma, Napa, Yolo, Colusa, Shasta, Lassen and Modoc, Cal., and Lake Malheur and Harney, Ore., to Boise City, Idaho. A branch is included to extend from Alturas, Cal., to Klamath Falls, Ore.

LOS ANGELES, OWENS VALLEY & UTAH.—The contract with F. E. Green, Los Angeles, Cal., for constructing and equipping this road between Mojave and Independence, Cal., 153 miles, provides for 4 eight-wheel locomotives, 50 box and flat cars, 2 upholstered coaches, 2 smoking cars, 2 baggage cars and mail and express cars, 6 depots, engine house, turntable, telegraph line and other equipment, at $1,995,000.

MONTEREY & FRESNO.—The contract for the construction of this road has been awarded to the California Construction Co., to be completed as stated June 8.

TACOMA & EASTERN.—The construction of 45 miles of this road will be commenced as soon as engineers can definitely locate the line. It will extend from Tacoma, Wash., through the valleys of the upper Nisqually, Corolitz and Tilton rivers.

Foreign.

MEXICO.—The contract has been signed by the department of communications and public works with Gen. Pedro Hinojosa, granting him a concession for a railway from Guanajuato to Dolores Hidalgo, with the right to extend it to San Luis de la Paz. Work must begin within 12 months, and 15 kilometers at least must be built each year, the whole being completed within eight years from the date construction begins. The gage may be either standard or narrow gage.

STREET RAILWAYS.

FALL RIVER, MASS.—The Globe St. Ry. Co. is reported as about to construct an electric railway between this city and New Bedford.

HAVERHILL, MASS.—The Haverhill, Georgetown & Danvers St. Ry. Co. has been incorporated by H. L. Perkins, W. W. Potter, W. H. Floyd and others to construct a street railway in the towns of Danvers, Topsfield, Boxford, Georgetown and parts of Groveland and Bradford; capital stock, $300,000.

NEWBURY, MASS.—The Essex County St. Ry. Co. has been incorporated by Milton Ellsworth, J. A. Marshall, D. H. Hale and others to construct a street railway in the towns of Newbury, Rowley and Ipswich; capital stock, $150,000.

WATERTOWN, MASS.—The Newtonville & Watertown St. Ry. Co., recently incorporated, has been granted permission to extend its tracks through this town. The trolley system will be used.

HARTFORD, CONN.—The Senate has passed resolutions amending the charters of the Middletown Horse R. R., New Britain Tramway, and Norwich St. Ry. companies, and incorporating the Moodus, Marlborough & Glastonbury St. Ry. Co; Manufacturers St. Ry. Co., New Haven; Portland St. Ry. Co. The House of Representatives has passed resolutions incorporating the Mad River Transit Co. and the Hartford Suburban R. R. Co.

LEWISTON, N. Y.—The Niagara Electric Ry. Co. has been incorporated to construct a street railway between and in the villages of Pekin and Lewiston; capital stock, $50,000; Harvey Hoag, M. L. Failing, J. G. Taylor, J. A. Kuck, of Buffalo.—It is reported that several companies are considering a road from Niagara Falls to Youngstown, through this city.

JACKSON, MISS.—The Jackson Electric Ry., Light & Power Co. has been incorporated; capital stock, $250,000.

CINCINNATI, O.—The Cincinnati St. Ry. Co. contemplates an early extension of its Cincinnati & Avondale Electric St. Ry. line westwardly through Mitchell Ave. to Winton Place, thus giving a through line of electric cars from the eastern and central portions of the city to the Spring Grove Cemetery. The capital stock of the company has been increased from $6,750,000 to $10,000,000.

NORWALK, O.—Bids will be received until July 3 for a franchise for a street railway in certain streets of the city. F. W. Christian, Cy. Clk. The Norwalk, Fairfield & Southern R. R. Co. has applied for the franchise.

OAKLEY, O.—The Cincinnati, Oakley & Madison Ave. St. R. R. Co. has been incorporated by Chas. L. Mills, John Seymour, J. F. Kinney and others to construct a road from this town to Erie Ave., Cincinnati; capital stock, $10,000.

PORTSMOUTH, O.—The Portsmouth St. R. R. & Light Co. has been incorporated; capital stock, $125,000.

GREENCASTLE, IND.—The Greencastle St. Ry. Co. has been incorporated with a capital stock of $100,000.

INDIANAPOLIS, IND.—The Citizens' St. R. R. Co. is preparing to extend its electric line to Brightwood this summer.

NEW ALBANY, IND.—The New Albany Ry. Co. has been authorized by the council to change its motive power to the trolley system.

EAST ST. LOUIS, ILL.—The East St. Louis Electric St. R. R. Co. has increased its capital stock from $150,000 to $500,000.

FORT SMITH, ARK.—It is reported that the Fort Smith & Van Buren Electric R. R. Co. will soon equip its line with electric motors. A railway will also be built to Van Buren. Address F. T. McCleary.

DENVER, COLO.—The Fairmount Ry. Co. has been incorporated to construct a road from Fairmount Cemetery to the town of Montclair; capital stock, $18,000; Willard Teller, Wm. H. Bush, Frank C. Young.

RIVERSIDE, CAL.—A company is being formed to construct an electric railway, for which a franchise has been asked; capital stock, $250,000.

HIGHWAYS.

RHODE ISLAND.—The town of Lincoln has appropriated $40,000 for highways.

NEW YORK.—The supervisors of Queens county will receive bids until June 30, at the town hall in Jamaica, for grading and macadamizing certain highways. F. W. Dunton, Chn.

NEW JERSEY.—The freeholders of Union county have designated Edgar turnpike as a county road; and a macadam roadway, 12 ft. wide, will be constructed as soon as possible. The board will issue 4% bonds for $50,000 for road construction.

MARYLAND.—A military road is proposed between Baltimore and Washington. Wallace Stebbins, Baltimore, is interested in the project.

OHIO.—Samuel Craig, Engr., will receive bids at the court house of Anglaize Co., at Wapakoneta, until July 6 for the grading, graveling, masonry, culverts and bridges on the river road pike, a distance of 11.9 miles; separate bids will be received for the stone arch at Smith's, masonry at St. Mary's river and St. Mary's river bridge.

MINNESOTA.—The commissioners of St. Louis county, at Duluth, have been petitioned to open several county roads. About $10,000 worth of work has been planned.

TEXAS.—The commissioners of Harris county will build about 20 miles of roads this year, it is reported. It has been suggested that four roads be constructed out of Houston a distance of five miles each.

BRIDGES.

BALTIMORE, MD.—The contract for building the brick and stone arch bridge over Jones Falls on North Ave. has been awarded to McCabe & Bro. for $319,915. The bids for the masonry in detail were: Coping, $22; pier coping, $25; abutment, $30; cast abutment, $12; spandrel, $12; ring, $13; pier ends, $10; pier bodies, $10; inner rib brick, $9; spandrel brick, $9; gravel concrete packing, $3; filling, $1.50; gravel filling, $1.50; false work, $37.

DAYTON, O.—Bids will be received by the board of city affairs, C. A. Herbig, city comptroller, until July 5, for the furnishing of material and construction of a wrought iron whipple truss bridge across Wolf Creek, consisting of one span of 160 ft. on pin centers; clear road, 24 ft.; two sidewalks, 6 ft. each; capacity, 100 lbs. per sq. ft. of floor surface. Bidders to furnish complete strain sheets, general plans of the proposed structure and detailed drawings clearly showing the dimensions of all the bids, modes of construction and the sectional areas.

WATER-WORKS.

DEER ISLE, ME.—The Pine Lake Water Co. has been organized to secure a supply; capital stock, $50,000; Pres., W. B. Thurlow; Treas., Chas. H. Flye.

PATTEN, ME.—A company has been organized to secure a gravity supply; capital stock, $4,000; Pres., Ira B. Gardner; Treas., D. Scribner; Clk., Bertram L. Smith.

ROCKLAND, ME.—The Rockland Water Co. has authorized Jas. Farnsworth, Pres., to employ an engineer to make plans for new works.

RUTLAND, VT.—The water-board has recommended that the contract for extensions be awarded to Inman Bros., New York, at about $48,523. Prices will be published next week.

CHICOPEE, MASS.—The following contracts have been awarded: Holly Mfg. Co., Lockport, N. Y., one compound high-duty crank and flywheel engine and two horizontal boilers, at about $15,500; Deane Steam Pump Co., Holyoke, one compound duplex pump, at $5,410; R. F. Hawkins, Springfield, 55 × 60 ft. iron stand-pipe, at $10,079; Inman Bros., New York, construction; Chapman Valve Mfg. Co., Indian Orchard, valves.

FRAMINGHAM, MASS.—The adjutant general has been authorized to take the waters of Leonard's Pond in this town to secure a supply for the state camp grounds.

MEDFORD, MASS.—M. M. Tidd, Boston, will be employed to make plans for improving and enlarging works, it is reported.

SCITUATE, MASS.—The Scituate Water Co. has been incorporated by D. Sanford Jenkins, L. T. Cushing, J. N. Turner and others to secure a supply for residents of this town; capital stock, $60,000.

ROCKVILLE, CONN.—A 20-in. main is to be put in from Snipser dam to Vernon Ave. and a 10-in. main from there to West St. Several 10-in. mains will be laid and no pipe used smaller than a 6-in. Arrangements for the high service have not been completed. H. W. Ayer, Engr., Hartford.

UNIONVILLE, CONN.—The water company has located positions for 30 hydrants.

ALDEN, N. Y.—The Alden Water-Works Co. has been incorporated; capital stock, $25,000; Geo. Z. Green, Binghamton; Frank Westcott, Seneca Falls; Jas. H. Moffatt, Buffalo.

DUNKIRK, N. Y.—The contract for extending the influent pipe into the lake is reported to have been awarded to Thatcher & Breyman, Toledo, O.

FAIRPORT, N. Y.—W. F. Randall, Syracuse, has reported that works will cost about $40,000. The supply will be secured from wells.

FLORIDA, N. Y.—The Florida Water-Works Co. has been incorporated with a capital stock of $20,000.

NEW YORK, N. Y.—The department of public works will receive bids until June 27 for laying mains in 16 streets.

SARANAC LAKE, N. Y.—It is reported that works will be constructed to cost $30,000.

STAMFORD, N. Y.—The Washington Water Co. has been incorporated with a capital stock of $20,000. The Stamford Water-Works Co. built works here in 1883.

ALLEGHENY, PA.—The committee has recommended that a consulting engineer be engaged to locate new works and prepare estimates.

BRADFORD, PA.—Bids are asked until June 26 for 19,600 ft. of 14-in. cast iron pipe, about 12,000 ft. of 8 to 4-ins. pipe and 12,000 lbs. of special castings; also hydrants, gates, etc. F. W. Dalrymple, Cy. Engr.; S. D. Heffner, Supt. W. Dept.

BROCKWAYVILLE, PA.—The Brockwayville Water Co. has been organized, and it is reported will take immediate steps to put in works; Treas., B. T. Chapin; Secy., C. H. Marshall.

EASTON, PA.—The South Easton Water Co. has decided to purchase a pump and to erect a pumping plant.

JOHNSTOWN, PA.—Frank A. Cresswell has been elected permanent engineer of the Conemaugh & Franklin Water Co. It is reported that bids will be opened this week for works.

ONEIDA, PA.—The Oneida Water Co. has been organized by E. B. Coxe, A. B. Coxe, E. B. Ely and others to secure a supply for residents of the townships of North Union and East Union.

PITTSBURG, PA.—The Monongahela Water Co. has voted to increase its capital stock $251,775, making a total of $1,850,000, to extend the service to Mansfield, McKee's Rocks, Enon, Sheridan, Melrose and other places. Work will be commenced at once upon the extensions.

SOUTH BETHLEHEM, PA.—The Mountain Water Co. has been organized by J. B. Meixell, Chas. A. Worsley and others to secure a supply from springs. The present supply is from the Lehigh River.

WILMINGTON, DEL.—Bids are asked for finishing and laying 600,000 to 1,000,000 hard brick. J. A. Bond, Ch. Engr.

CUMBERLAND, MD.—J. W. Galbreath has been authorized to receive bids for a 4,000,000-gallon pumping engine. The board is also about to purchase $30,000 worth of pipe, the bonds for which were recently voted.

GREENCASTLE, MD.—The council has decided to secure a supply from a spring two miles distant.

HAGERSTOWN, MD.—The Washington County Water Co. is preparing to secure an additional supply, at an estimated cost of $22,000 to $100,000, according to the plan accepted.

BERKLEY, VA.—The council has passed the ordinance granting the Berkley & South Norfolk Water & Electric Light Co. permission to put in works.

LYNCHBURG, VA.—L. P. Rodes, Cy. Engr., M. H. Garland, Cy. Surv., and R. Taylor Graves, Consult. Engr., have reported in favor of a gravity supply, and an additional appropriation has been made to continue the investigations. The present works were built by the city in 1828 and the supply is from the James River.

CELINA, O.—Works are being agitated.

HILLSBORO, O.—The contract for works has been awarded to the Boughen Engineering Co., Cincinnati, at $68,785. The contract includes at least twelve 8-in. wells, approximately 50 ft. deep, properly connected; brick pumping station; two 1,000,000-gallon compound duplex pumps, with boilers and all appurtenances; one stand-pipe, 15 × 160 ft., with foundation for same; and a distribution system of about 9.05 miles of 10 to 4-in. pipe, with valves, etc., and 68 fire hydrants. Edward Fladd, Consult. Engr., St. Louis, Mo.

LINWOOD, O.—The citizens have voted an additional $30,000 to complete the water-works and electric light plant.

NORWALK, O.—An election will be held Aug. 1 to vote on the issue of bonds for $100,000 for the renewal of the present system and construction of new works.

NORWOOD, O.—Bids are asked until July 3 for a covered reservoir, 40 × 60 ft., and an open tank, 20 × 15 ft., including steel and iron superstructure and masonry foundations. G. Bouscarn, Consult. Engr., Cincinnati.—An election has been called for July 12 to vote on an issue of $50,000 of water bonds. A similar amount has already been voted.

WYOMING, O.—The village will receive bids for extensions of mains in three streets. E. F. Layman, Engr., 64 W. Third St., Cincinnati.

BELDING, MICH.—Wm. Just, Grand Rapids, represents Eastern capitalists who desire a franchise. The council has granted permission for an engineer to make surveys.

CRYSTAL FALLS, MICH.—It is reported that the village will spend $15,000 for new works.

DETROIT, MICH.—Extensions have been ordered in three streets.

SPRING LAKE, MICH.—It is reported that the citizens are urging the necessity of works.

GARDNER, ILL.—The village council is considering the question of works.

OTTAWA, ILL.—It is reported that bonds will be issued for $60,000.

APPLETON, WIS.—W. F. Goodhue, Milwaukee, has been employed to report on the efficiency of the works built in 1882 by the Wiley Construction Co. in case of fire.

PETERSON, IA.—It is reported that bonds have been voted for works.

DILLON, MONT.—Bids are asked until July 5 for works, as stated in our advertising columns. Ray & Tingle, Engrs., Butte. Bids will be received July 8 for $45,000 of bonds.

ST. LOUIS, MO.—Bids will be asked at once for two new engines at Bissell's Point.

WEST PLAINS, MO.—It is reported that steps are being taken to secure estimates for works.

TEMPLE, TEX.—The Temple Water-Works Co. desires bids on a stand-pipe. Geo. E. Wilcox.

COLORADO SPRINGS, COLO.—The city desires bids for $25,000 of bonds recently voted for extensions.

GRAND JUNCTION, COLO.—David R. Crosby, Cy. Surv., and the special committee reported in favor of a gravity supply from springs, at an estimated cost of $66,543.

RICE, COLO.—A petition is being circulated asking that bonds be issued for works.

GENESEE, WASH.—The city is considering a proposition to issue bonds for works.

PUYALLUP, WASH.—The council is considering the issue of bonds for $60,000 for works.

WALLACE, IDAHO.—The citizens have voted to issue bonds for $30,000 for works and improvements.

SKAMOKAWA, WASH.—The Skamokawa Water Co. has been incorporated with a capital stock of $2,000.

GRANT'S PASS, ORE.—The Rogue River Water, Light & Power Co. has been incorporated to operate water and electric light works; capital stock $50,000.

OREGON CITY, ORE.—The council has apthorized the issue of bonds for $10,000 for a new pump and improvements of works.

PORTLAND, ORE.—Bids are asked until June 30 for $300,000 of bonds. Frank T. Dodge, Clk. W. Com.

EIK GROVE, CAL.—The Elk Grove Water Co. has been incorporated to secure a supply; capital stock, $5,000; Chas. H. Dixon, W. E. Everson, J. I. Chinnick and others.

VALLEJO, CAL.—The following bids were received June 7 for reservoirs: Phillips & Searls, $30,486; G. Schmidt, $37,091; Ferris & Williams, $44,315; Healy-Tibbetts Co., $42,220, all of San Francisco; Portland Const. Co., Portland, $30,575; A. McKinnon & Co., Stockton, $51,100.

ARTESIAN WELLS.

LYONS, KAN.—The water-works committee has recommended that a 4-in. well be driven, as an experiment.

BURNS, ORE.—Bids are asked until July 5 for an 8-in. well. P. L. Shidelers, Clk. Co. Court.

WINNIPEG, MAN.—The Winnipeg Water-Works Co. is reported as about to bore a series of test wells. The present supply for the city is pumped from the Assiniboine River.

IRRIGATION.

SOLEDAD, CAL.—It is reported that the Soledad Dam & Storage Co. will construct a pipe line from its reservoir to the dam, a distance of 40 miles. About 4,000,000 ft. of redwood lumber will be required.

NEW COMPANIES.—Twin Lake Reservoir, Storage & Canal Co., Pueblo, Colo., $200,000; to construct a dam across Twin Lake Creek for storing water for irrigating purposes along the line of the Arkansas River; A. Park, A. E. Graham, H. N. Barks.——Socorro Land & Irrigation Co., Socorro, N. Mex.; $50,000; John W. Terry; C. T. Brown, Jos. Price, J. G. Fitch.——Butte County Irrigation & Land Co., San Francisco, Cal.; $1,000,000; Frederick Homer and B. S. Taylor, San Francisco; D. P. Merrill, Moore's Station.——Payette & Weiser Ditch Co., Weiser, Idaho; $60,000; to construct a canal to irrigate 30,000 acres, work to commence soon.—Tropic Ditch Co., Paonia, Colo.; $2,000.——Amity Land & Irrigation Co., Denver, Colo.; $500,000; W. J. Hallack, R. S. Coates, A. N. Parrish.——Beaver Brook Reservoir & Canal Co., Denver, Colo.; $150,000; to own reservoirs in Arapahoe, Jefferson, Boulder and Weld counties.

SEWERS.

LAWRENCE, MASS.—The contract for the Water St. sewer has been awarded to Andrew W. Bryne, Somerville, at $41,358.

LINCOLN, R. I. (P. O., Central Falls).—An appropriation of $60,000 has been made for sewers.

PROVIDENCE, R. I.—The council has appropriated $32,500 for a sewer in West Ave.

BUFFALO, N. Y.—The following bids have been received for a sewer in one street: A. D. McConnell, $9,871; E. J. Green, $11,789; F. J. Martin, $11,876; W. Franklin, $13,880; Thos. McKeown, $14,000; W. G. Smith, $14,937. The department of public works will receive bids until July 1 for 63 to 12-in. brick sewers.

FLUSHING, N. Y.—Bids will be received until June 26 for 2,800 ft. of 24 to 9-in. pipe sewer. G. A. Houllier, Engr.

HAVERSTRAW, N. Y.—Plans for a separate system have been completed by Lawlor & House, Poughkeepsie; total length, 8.9 miles; estimated cost, $50,000.

ILION, N. Y.—Bids are asked until July 6 for 10.6 miles of pipe sewers. The bids received June 6 for this work were published last week, but were rejected because of an error in the lowest bid. Anthony Steber, Secy. Comn.

NEW BRIGHTON, N. Y.—Plans have been prepared for sewers in six streets.

TROY, N. Y.—The contracting board will receive bids until June 27 for a brick sewer in one street.

WHITE PLAINS, N. Y.—It is reported that a Shone ejector will be used to dispose of the sewage in the eastern part of the village; estimated cost, $11,000.

BRIDGETON, N. J.—Plans for a system were prepared by Prof. Chas. McMillan, Princeton, about a year ago, and the city is now being canvassed for the necessary petition to council for construction. Ed. M. Fithian.

ERIE, PA.—The council has ordered ordinances prepared for sewers in four streets.

HAZLETON, PA.—A. Brooks Celiax, Cy. Engr., informs us that bids will soon be asked for 225 ft. of 8 to 6-ft. stone arch sewer, estimated to cost $2,000, and that plans have been prepared for 500 ft. of 15-in. pipe sewer.

LANCASTER, PA.—S. C. Slaymaker, Cy. Engr., informs us that the street committee has ordered twelve 2 to 6-ft. extensions, each from 60 to 1,400 ft. in length.

MONTROSE, PA.—The citizens have requested the town council to employ an engineer to make plans for a system.

MOUNT PLEASANT, PA.—O. P. Sharpe has applied for a franchise for a system.

PITTSBURG, PA.—The council has passed ordinances for sewers in 30 streets.

READING, PA.—J. G. Yarnell has been awarded the contract for a sewer in Muhlenberg St., at $21,624. An ordinance is before the council appropriating $60,000 for a sewage disposal plant.

WASHINGTON, D. C.—The contract for section A of the main Anacostia sewer has been awarded to M. F. Talty, at $10,232. A contract has also been awarded to B. F. Coyle, at $6,203.

MACON, GA.—An election was held June 21 to vote on the issue of sewer bonds for $200,000. Plans have been prepared for about 30 miles of 24 to 6-in. pipe sewers; estimated cost, $190,000. C. W. Hendrick, Cy. Engr.

WEST END, GA.—J. A. Caldwell, Cy. Clk., informs us that the election to vote on the issue of $50,000 of bonds for a sewer system has been postponed indefinitely.

COVINGTON, KY.—Plans have been prepared for important extensions in the western part of the town.

ASHTABULA, O.—Bids will be received until July 1 for sewers in five streets, about 10,300 lin. ft. A. B. Phillips, Cy. Clk.

CINCINNATI, O.—The board of administration will receive bids until June 29 for a sewer in one street.

CLEVELAND, O.—Bids will be received until July 5 for sewers in two streets. J. H. Farley, Dir. Pub. Wks. Additional work has been ordered.

DAYTON, O.—Bids will be received until July 10 for about 3,500 lin. ft. of 36 to 24-in. brick sewers, and 90,000 lin. ft. of pipe sewers, as noted in our advertising columns. Cady Staley and Geo. S. Pierson, Engrs., Kalamazoo, Mich.

OBERLIN, O.—Bids will be received until July 3 for 6,300 ft. of 8-in. and 24,300 ft. of 6-in. pipe sewers, as stated in our advertising columns. W. B. Gerrish, Engr.

TIFFIN, O.—Bids will be received until June 30 for a tile sewer. J. Rex, Cy. Clk.

SHELBYVILLE, IND.—It is reported that a complete system will be constructed.

KALAMAZOO, MICH.—The council has ordered sewers built in six streets.

MUSKEGON, MICH.—The board of public works has received five bids for lateral sewer No 2, the lowest being that of S. J. Perry, Bay City, $27,063.

CHICAGO, ILL.—The council has directed the superintendent of sewers to prepare plans for a system in the territory bounded by 39th and 63d sts. and Johnson and Oakley Aves.

JOLIET, ILL.—The mayor and council will visit the World's Fair to obtain information for the projected sewer system in this city.

LINCOLN, ILL.—A. H. Bell has been engaged to prepare plans for a system.

MADISON, ILL.—Bids will be received until July 1 for the construction of 6,092 ft. of 24 to 8-in. pipe sewers. M. B. Smith, Mem. Com.

FORT HOWARD, WIS.—The council has passed ordinances for two sewers.

DUBUQUE, IA.—W. H. Knowlton, Cy. Engr., has prepared plans for draining the upper part of the city.

SIOUX CITY, IA.—Bids will soon be asked for storm water and pipe sewers in several streets.

FARGO, N. DAK.—A contract has been awarded to Tobin & Greacon, Minneapolis, at $9,771.

KALISPEL, MONT.—An election will be held July 3 to vote on the question of sewers.

ST. LOUIS, MO.—The council has passed ordinances for seven sewers. Plans are being prepared for additional sewers in the Lowell district.

RICO, COLO.—A petition is being circulated asking that bonds be issued for water-works and sewers.

MONTESANO, WASH.—The contract for a system has been awarded to Cochran Bros., at $11,000. It is reported that the engineers' estimate was $15,000.

BENICIA, CAL.—Muddox & Co., Sacramento, have been awarded the contract for a sewerage system here.

FRUITVALE, CAL.—L. Kehoe has been awarded a contract, at $29,948.

MONTREAL, QUE.—The residents of St. Louis du Mile End have voted to borrow $100,000 for sewers.

STREETS.

CENTRAL FALLS, R. I.—The town of Lincoln has appropriated $25,000 for paving Broad St.

NORWICH, CONN.—The city has voted $19,500 for the street department, $3,000 for paving Central wharf, and $4,000 for widening Thames St.

ALBANY, N. Y.—The council has voted to pave Hawk St. with granite blocks; estimated cost, $5 per lin. ft.

GREENBUSH, N. Y.—The village surveyor is preparing plans for paving with granite blocks and cobblestones.

LOCKPORT, N. Y.—Specifications for paving Mulberry St. are nearly ready and the work will be commenced as soon as possible.

MOUNT VERNON, N. Y.—The contract for paving Fourth Ave. has been awarded to the Barber Asphalt Paving Co., at $27,657.

POUGHKEEPSIE, N. Y.—W. W. Smith is corresponding with other cities to ascertain the probable cost of asphalt and block pavements.

ROCHESTER, N. Y.—The council has passed ordinances for paving several streets with asphalt, brick and Medina stone.

SYRACUSE, N. Y.—The council has been petitioned to extend Walton St., 66 ft. wide, from Clinton to Salina Sts.; estimated cost, $200,000 to $400,000.

EAST ORANGE, N. J.—The contract for macadamizing Carnegie Ave. has been awarded to Thos. Nevins & Son, at $20,000, and other paving contracts to Andrew McDermott, Riley Bros. and the New York Roofing Co.

ORANGE, N. J.—Bids are asked until July 3 for improving certain streets. M. A. Brennan, Chr. St. Com.

BRADDOCK, PA.—The town council has ordered the paving of several streets with vitrified brick.

LANCASTER, PA.—S. C. Slaymaker, Cy. Engr., informs us that the street committee has ordered the following work, for which plans have been prepared, but that no contracts have yet been awarded: Paving 2 squares, about 60 lin. ft., with Belgian blocks; 2 squares with asphalt blocks, 10 squares with macadam and 1 square with vitrified brick, the first brick paving to be done in the city.

NEWPORT, KY.—Bids will be received until June 29th for paving with brick or asphalt, as stated in our advertising columns.

BEREA, O.—Bids are asked until July 10 for grading and paving with brick. C. F. Lane, Town Clk.

BUCYRUS, O.—Bids will be received until July 11 for improving several streets. W. A. Blicke, Cy. Clk.

DAYTON, O.—Contracts have been awarded as follows: Warren-Scharf Asphalt Paving Co., paving four streets with asphalt, $149,497; Trinidad Asphalt Paving Co., asphalt, $39,930; Ed. Ryan, Hayden block, $15,650; and Hallwood block, $8,158; W. A. Cain, Hayden block, $22,434.

MARTIN'S FERRY, O.—Bids will be received until June 26 for 2,500 lin. ft. curbing. F. Allender, Cy. Clk.

SPRINGFIELD, O.—The board of public affairs will receive bids until July 11 for curbs, gutters, brick and cement walks, etc. S. J. Wilkerson, Cy. Clk.

LANSING, MICH.—The city engineer has been directed to prepare estimates for improving certain streets.

SAGINAW, MICH.—The board of public works has voted to improve several streets.

GREEN BAY, WIS.—Bids will soon be asked for paving Washington St. X. Parmentier, Cy. Clk.

KANSAS CITY, MO.—Contracts for paving have been awarded to the Barber Asphalt Paving Co., at $19,797 and $8,777 for asphalt, and to F. P. McCormick, at $20,946 for brick.—The board of public works will pave Independence Ave. from Grand to Highland Ave. with asphalt. Other work has also been ordered.

LOS ANGELES, CAL.—C. E. Crowley bid $24,500 and D. F. Donegan $17,940 for grading certain streets.

TORONTO, ONT.—The Toronto Vitrified Paving Brick & Stone Co. has been incorporated by Robt. W. Prittie, W. J. McWhinney, Thos. Downey and others; capital stock, $500,000.

ELECTRIC LIGHT AND POWER.

NEW YORK, N. Y.—The Department of Public Parks will receive bids until June 28 for a subsidiary electric lighting plant at the Metropolitan Museum of Art, in Central Park.

TONAWANDA, N. Y.—The Tonawanda & Wheatfield Electric Light Co. has offered to light the village at $90 a year per lamp, and the council rooms, hose-houses, etc., without expense, but the council has accepted the bid of the Tonawanda Gaslight Co. to furnish all the lamps needed at $18 each per year.

WOODHAVEN, N. Y.—The town board will receive bids until July 7 for lighting the streets with arc lights.

LUDLOW, KY.—Bids are asked until July 6 for electric street lighting. J. C. Richardson, Cy. Clk.

LINWOOD, O.—The citizens have voted $30,000 to complete the electric light and water-works plant.

TIFFIN, O.—Bids are asked until July 7 for lighting the streets for five years from Dec. 1. About 120

arc lights of 2,000 c. p. will be required. J. Rex, Cy. Clk.

DES MOINES, IA.—The contract for street lighting for two years has been awarded to the Water Power Electric Co., at $6 per light per month for arc lights.

MELLETTE, S. DAK.—J. H. Hatchard, Town Clk., informs us that the contract for a plant has been awarded to M. B. Potter & Co., the town agreeing to take 200 incandescent lights for two years and to furnish the lamps. An artesian well will furnish the power.

CHEHALIS, WASH.—The city council has voted to put in a power plant in connection with the electric light plant. The city is now paying $310 per month for power.

WENATCHEE, WASH.—M. E. Schinn has been granted a franchise and will soon put in a plant.

LOS ANGELES, CAL.—Peter Kepl, W. R. Porter and W. E. Van Slyke, who are interested in the electric light plant in San Bernardino, have been at work for some months on a project to supply this city with electricity for lighting, electric railways and for manufacturing purposes. A ditch and tunnel, formerly used for hydraulic mining upon the mountain, have been repaired and it is reported that a complete electric plant will soon be in operation.

NEW COMPANIES.—Trenton Electrical Const. Co., Trenton, N. J.; $25,000; G. F. Applegate, Z. P. Toman, C. F. Adams.—C. & C Electric Co, Newark, N. J., $1,400,000; J. L. Wilkie, Flushing, N. Y.; Geo Dann, New York; L. McK. Garrison, Orange.—Tichenor Light & Power Co., for the U. S. A., Chicago, Ill.: $1,000,000; A. C. Tichenor, A. C. Hawley, Alonzo Hertig.—Novelty Electric Co., Chicago, Ill.; $10,000; M. Carter, B. Carter, Edwin G. Lancaster.—Columbian Electrical Co., St. Joseph, Mo.; $2,000; Geo. C. Rough, C. E. Roehl, F. C. Barrington.—Eagle Electric Mfg. Co., South Superior, Wis.; $4,000; A. Striemer, E. A. Noble, O. J. Graham.—Riverside Electric Power Co., Riverside, Cal.; $100,000; Geo. L. Bush, Fred Carter, J. T. Jarvis.—International Storage Battery Co., Detroit, Mich.; $100,000; Mfg. Woodward's Tubular Secondary Electric Storage Battery, etc.—Independent Electric Co., Chicago, Ill.; $25,000.—Tri-City Power & Light Co., Rock Island, Ill.; $300,000.

CONTRACT PRICES.

BRICK PAVING.—Auburn, N. Y.—J. M. Mack & Co., Syracuse, offered to pave with Corning re-pressed brick on concrete, at $2.25 per sq. yd. with Portland cemcnt filling, and $2.70 with asphalt filling; new curb, 70 cts. per lin. ft.; old curb redressed, 42 cts.; catch basins, $1.

Titusville, Pa.—John Osborne, Franklin, has been awarded a contract for paving with brick, as follows: Excavating and refilling, 33 cts. per cu. yd.; curbing, 45 cts. per lin. ft.; Franklin paving brick, laid, $1.20 per sq. yd.; Brady's Run brick, $1.30; New Lisbon brick, $1.35.

PIPELAYING AND RESERVOIR.—Bradford, Pa.—F. W. Dalrymple, Cy. Engr., informs us that the following bids were received for laying cast iron pipe: Kelley & Sheehan, 8 to 4-in. pipe, 12,350 lin. ft., at 30 cts.; 16-in., 23,800 lin. ft. at 42.5 cts.; King & Lain, 26.5 and 46 cts.; M. B. Birdseye, 30 and 50 cts. For the 60,000,000-gallon reservoir the bids are in this order: 1, grubbing; 2, rock excavation; 3, earth excavation; 4, puddling; 5, masonry; 6, total.

	1.	2.	3.	4.	5.	6.
King & Lain.....	$110	$.70	$.38	$.08	$3 25	$22.337
Kelley & Sheehan..	120	.90	.27	.10	6.00	22.641
Hingston & Tench.	90	.95	.34	.29	7.40	33.419
John McCann & Co.	120	1.00	.20	.12	12.00	25.746
M. B. Birdseye....	100	1.50	.35	.20	6.75	30,842

SEWERS.—Boston, Mass.—Bids have been received for sections 30 and 44 of the Metropolitan main sewer: Section 30.—Christopher McBride, Brighton, 1, earth excavation and refill, 41 × 44 ins., 2.20 lin. ft., at $4.; 2, 34 × 36 ins. and 32 × 34 ins., 3.025 lin. ft., at $4; 3, 27 × 28 ins., 1.795 lin. ft., at $4; 4, brick masonry, American, 1,200 cu. yds., at $14; 5, Portland, 440 cu. yds., at $16; 6, concrete masonry, American, 450 cu. yds., at $6; 7, Portland, 280 cu. yds., at $7.50; 8, spruce lumber in place, 50 M. ft. B. M., at $37; 9, spruce piles in place, 14,000 lin. ft. at 40 cts.; total, $63,430. Everson & Liddle, Providence, 1, $5; 2, $5.50; 3, $3; 4, $17; 5, $14.50; 6, $6; 7, $7.50; 8, $35; 9, 25 cts.; total, $64,352. Jones & Meehan, Jamaica Plain, 1, $2.80; 2, $3.50; 3, $3.80; 4, $13; 5, $15; 6, $5; 7, $7; 8, $30; 9, 20 cts.; total, $56,786. Section 44.—Everson & Liddle, 1, earth excavation and refill, 31 × 35 ins., 3,070 lin. ft.; 27 × 30 ins. and 24 × 29 ins., 2,530 lin. ft. at $4; 4, 380 cu. yds., $14; 5, 320 cu. yds., $15.50; 6, 300 cu. yds., $6; 7, 170 cu. yds., $7.60; 8, 10 M., $35; total, $36,122. Jones & Meehan, 1, $3.40; 4, $14; 5, $17; 6, $7; 7, $9; 8, $40; total, $33,830.

Both contracts were awarded to Jones & Meehan, as stated in our issue of June 8.

Washington, D. C.—The contract for a main intercepting sewer from the Potomac River near Easby's Point to near the intersection of Fifteenth and E streets northwest has been awarded to H. L. Cranford, Washington, at $206,227, the prices being as follows: Earth excavation in trench for 11 ft. 3 ins.x11ft. 3 ins. D-shape sewer above sewer subgrade, $5.55 per lin. ft.; for 11 ft. 3 ins. circular, $11.47; 10 ft. 6 ins. circular, $9.36; 9 ft. 8 ins. circular, $6.75; for junction section of sewer, $7.25; 6 ft. 6 ins. circular, $3.70; 6 ft. 3 ins. circular, $3; rock excavation, $1.50 per cu. yd.; brick masonry, American cement (one part cement to two parts sand), $8.60 per cu. yd.; vitrified brick masonry, Portland cement (one part cement to two parts sand), $16.35; concrete masonry in place, American, $4.95; Portland, $7.75; rubble masonry, American, $4.50; bluestone coping, Portland cement, 60 cts. per sq. ft.; lumber in place, $32.50 per M. ft. B. M.; earth excavation below sewer subgrade, 80 cts. per cu. yd.; gravel refilling below sewer subgrade, 90 cts. per cu. yd.; lumber for setting and shoring in place, $15 per M. ft. B. M.; 4, 6, 8, 10 and 12-in. drain pipe, 15, 18, 21, 24 and 30 cts. per lin. ft., respectively; pile foundations, six piles wide, $10.25 per lin. ft.; earth excavation outside of sewer trench and above sewer grade, 78 cts. per cu. yd.; extra excavation in compressible material 18 ins. wider on each side than masonry and refilling, $1 per lin. ft.; embankment over 11 ft. 3 ins. D-shape, sewer to be consolidated in 6-in. layers, 30 cts. per cu. yd.; all extra work, its actual cost plus 15%. The total bids received were published in our issue of June 8.

MISCELLANEOUS.

GARBAGE CREMATORIES.—Lawrence, Mass.—The mayor and board of health have been authorized to purchase a garbage crematory, at a cost not to exceed $8,000.

Portland, Ore.—The council is considering an ordinance providing for the purchase of land and erection of a garbage crematory, at a cost of $15,000.

Oakland, Cal.—The board of health has petitioned for $15,000 for a garbage crematory.

PARKS.—Westfield, Mass.—Jas. A. Lakin and R. B. Crane are interested in a proposed park at this place.

Toledo, O.—The park commissioners have appropriated $75,000 for a park in East Toledo.

Philadelphia, Pa.—The commission appointed by the governor to have charge of the Valley Forge Park, for which the legislature appropriated $25,000 for the land desired, has organized by electing Francis M. Brooke, president, and Frederick D. Stone, secretary.

San Diego, Cal.—It is reported that a landscape architect has been sent to Honolulu to make drawings for a 160-acre park to be opened near this place by the electric railway company owned by J. D. Spreckles and others; estimated cost, $75,000.

PARK IMPROVEMENTS.—New York, N. Y.—The department of parks will receive bids until June 28 for 63,500 sq. ft. paving with rock asphalt, 1,660 lin. ft. granite steps, 300 cu. yds. rubblestone masonry, 500 lin. ft. stone coping, 2,200 lin. ft. 8 and 6-in. pipe sewer, 560 lin. ft. 30-in. pipe sewer, etc.

STEEL CRANE.—Washington, D. C.—The following bids have been received for a 40-ton locomotive crane for the Mare Island Navy Yard: S. C. Forsaith Machine Co., Manchester, N. H., $48,697; Wm. Sellers & Co., Philadelphia, $51,950.

MASONRY, ETC.—Wapakoneta, O.—Bids are asked until July 6 for a stone arch, masonry and bridge. Samuel Craig, Engr.

RETAINING WALL.—Ballston Spa, N. Y.—The street commissioner has been authorized to advertise for bids for relaying the retaining wall on the north side of West High St., along Gordon Creek.

Boston, Mass.—The park commissioners will receive bids until June 26 for a retaining wall of Roxbury stone on the parkway.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Pittsburg Locomotive Works, Pittsburg, Pa., have an order for 20 tank engines for the Manhattan elevated road, New York.

The Brooks Locomotive Works, Dunkirk, N. Y., are building 15 engines for the Illinois Central.

The Rauh Locomotive, with vertical cylinders, is said to be ready for preliminary tests.

CARS.—The South Baltimore Car Co., Baltimore, Md., is building 600 coal cars, fitted with air brakes and automatic couplers, for the Gaston Coal & Coke Co., Fairmont, W. Va.

The Litchfield Car & Machine Co., Litchfield, Ill., has an order for 200 box cars for the Missouri, Kansas & Texas. The works are being enlarged.

The Laconia Car Co., Laconia, N. H., is building 12 passenger cars, 5 baggage cars, 3 smoking cars and 2 construction cars for the Maine Central.

The Central Indiana Car Works, of Chicago, Ill., have been incorporated by J. D. McKittrick, C. D. Miller, and M. D. Pontius, with a capital stock of $500,000.

BRAKE VALVE.—The Minneapolis Air Brake Improvement Co., with a capital stock of $500,000, is to be formed for the purpose of manufacturing a new brake valve invented by John K. Lencke, a fireman on the Chicago, St. Paul, Minneapolis & Omaha.

THE AIR BRAKE PRESSURE REGULATOR CO., Chicago, Ill., has been incorporated for the purpose of manufacturing devices for increasing brake pressure as the load increases and preventing the skidding of wheels on cars. It is adapted to any air brake. The company is prepared to equip either new or old cars. Pres., A. C. Ray; Sec'y and Treas., Benjamin Wolhaupter; Supt., O. W Dean. The company has offices in the Monadnock Block, and has an interesting exhibit at the World's Columbian Exposition, in the Transportation Building Annex, Sec. P. S., Posts4 to 8.

THE GOULDS MFG. CO., Seneca Falls, N. Y., exhibits at the World's Columbian Exposition an extended display of triplex power pumps for almost every service, water lifters, etc. Nearly all will be in practical daily operation. A 10 × 12-in. triplex power pump, direct connected and operated by an Ideal engine, is in service in the boiler plant, Machinery Building. This pump is used for operating some 4,000 HP. Heine boilers, the hot water being taken from a Webster vacuum steam economizer. The company has headquarters in section H, 15, Machinery Building.

RAILWAY EQUIPMENT.—The contract with F. E. Green, Los Angeles, Cal., for 153 miles of the Los Angeles, Owens Valley & Utah, between Mojave and Independence, Cal., calls for 4 eight-wheel engines, 50 box and flat cars, 2 passenger cars, 2 smoking cars, 2 baggage cars and a mail and express car.

WATER-WORKS APPLIANCES.—The following references are made to the exhibit of water-works appliances at the annual meeting of the New England Water-Works Association, held at Worcester, Mass., June 14 to 16; the exhibit this year, for the first time, was in charge of the associate members, that is, the exhibitors, and was a marked success:

Meters.—The Union Water Meter Co., Worcester, Mass., had an advantage over all the other exhibitors this year in that their works are located in Worcester and were visited by the members of the association. At the exhibit rooms the company had on view meters ranging in size from ⅝ to 2 ins. At their shops meters up to and including 12 ins. in diameter were seen.

The Hersey Manufacturing Co., South Boston, Mass., showed a 6-in. and two smaller meters.

The National Meter Co., New York city, had on exhibition ¼-in. Nash, ½, ¾ and 1-in. Crown, ½-in. Empire and ½-in. Gem meters.

The Thompson Meter Co., Brooklyn, showed a ½ and a 1¼-in. Bee meter.

The Thompson Hydraulic Co., New York city, exhibited the Neptune disk meters in sizes ranging from ⅝ to 6 ins., inclusive.

Henry A. Worthington showed a ¾ and a ⅝-in. meter.

The Weir Meter Co., Salem, Mass., had on exhibition a ⅝, ½ and 4-in. meter, the latest, we believe, put on the market.

Meter Connections.—"The Handy" meter connections were exhibited by B. C. Smith, New York city, and consist of a stop coupling on the street service and a stop and waste, with check valve, on the house side of the meter, both close to the meter. In the same exhibit was a curb shut-off and an eel guard for insertion in the street mains at taps.

Knuckle Joints.—The Geo. Woodman Co., Boston, exhibited the Gorham knuckle joints, by means of which a shut off cock in a cellar may be turned from any part of a building. The joints are placed at changes in direction in a rod or series of rods connecting with the cock. At Laconia, N. H., one cock is operated at a distance of 100 ft. with these joints.

Pipe Cutting Machine.—B. C. Smith, New York city, exhibited an 8-in. French Pipe Cutting Machine in operation. A 24-in. cast iron pipe, 1 1-16 ins. thick, has been cut with this machine in 23 minutes. The machine is made in three sizes, the smallest cutting pipe from 8 ins. down, the next, 16 to 10 ins., inclusive, and the largest, 24 to 18 ins., inclusive. The pipe is cut clean the whole way around, without waste, which effects a large saving of metal, especially on large pipe.

Pipe Tapping Apparatus.—Anthony C. Smith, Newark, N. J., showed one of his machines, with a full set of tools, for tapping a water main without shutting off the water; the machine exhibited taps from 2 to 6-in. mains, but it is made in large sizes. It will tap a main for any size connection up to the diameter of the original pipe.

Asbestos and Vulcabeston.—H. W. Johns & Co., through a New England agent, had on exhibition a full line of asbestos and vulcabeston goods used for waterworks purposes. Vulcabeston and molded mica are largely used in connection with water-works, the asbestos for packing to prevent the radiation of heat, and the vulcabeston for valve packings. In addition there are numerous other well known uses for these materials.

Valves and Hydrants.—The Rensselaer Manufacturing Co., Troy, N. Y., showed an 8-in. valve; the Fairbanks Co., Boston, a lift and a check valve; the Walworth Manufacturing Co., Boston, gate valves; the Michigan Brass & Iron Foundry, Detroit, valves and a hydrant; the Coffin Valve Co., Boston, Mass., iron and brass valves of various sizes, a 4-cluster 16-in. check valve, drawings and a hydrant; the Ross Valve Co., Troy, N. Y., 6-in. special regulating valve to maintain a constant pressure without regard to volume of flow and also straightway gates and pressure reducing valves. The latter company also had on exhibit steam diaphragm reducers for car heating.

The Geo. Woodman Co., Boston, exhibited stop and waste cocks, and the Taunton Locomotive Works, Taunton, Mass., stop cock boxes.

Melting Pots and Tools.—A lead melting pot and furnace were shown both by the Taunton Locomotive Works, Taunton, Mass., and by Perrin, Seamans & Benedict, Boston; the latter concern had a pot and furnace mounted on wheels.

The Borden Patent Pipe Wrench was exhibited by Henry F. Jenks, Pawtucket, R. I.; this wrench is now made for use on pipe up to 6 ins. in diameter, and will be made for use up to 14-in. pipe. Pipe wrenches and various other tools were also exhibited by the Walworth Manufacturing Co., and Perrin, Seamans & Co., both of Boston, the latter showing a pipe derrick.

Steam Specialties and Pressure Regulators.—The Fairbanks Co., Boston, exhibited steam specialties; the Thompson Hydraulic Co., New York city, a steam indicator; the Curtis Regulator Co., Boston, balanced steam traps and steam and water regulators; S. P. Jones, Boston, the Peerless Regulator and a test gage. The Crosby Steam Gage & Valve Co., New York, was also represented, and the Ross Valve Co., Troy, N. Y., had on exhibit the special pressure regulator and the reducing valves mentioned above.

Valve Indicator.—R. D. Wood & Co. exhibited a device for indicating the position of valves on street and yard mains.

Drawing Instruments.—Frost & Adams, Boston, showed some fine drawing instruments.

Fire Hose.—The Crosby Steam Gage & Valve Co. showed some hose and a hose support for use on public buildings.

Service and Main Pipe.—The National Tube Works Co., McKeesport, Pa., had on exhibition from its Boston office samples of kalamein and black enamel pipe and also their welded pipe up to 24 ins. in diameter.

Well Points.—The Hydraulic Construction Co., New York city, exhibited a 6-in. non-corrosible well point with a gage offset to give a strainer service many times larger than the cross-section of the pipe; also a 3 and 1¼-in. well point.

WATER-WORKS AT SHREVE, OHIO.

Sealed proposals will be received until July 8, 1893, by the board of water-works trustees of Shreve, O., for the construction of a system of water-works in Shreve, O. Plans, specifications and contracts will be on exhibition at the clerk's office of the board of trustees after June 14, 1893.

Blank forms of plans, specifications and contracts will be furnished on application. Each bid must be accompanied by a certified check to the amount of $200 as a guarantee of good faith. The right to reject any and all bids reserved.

DAVID E. FOLTZ,
Chairman Board of Trustees,
25-2t

FURNISHING AND LAYING WATER PIPE

AT "INGLESIDE," THE PROPERTY OF JERE JOHNSON, JR., AT FLUSHING, QUEENS COUNTY, NEW YORK.

Proposals for furnishing and laying approximately 6,800 ft. of water mains varying in size from four (4) to eight (8) inches; together with gates and hydrants required, will be received by the undersigned until 12 o'clock noon on July 1st, 1893.

A certified check in the sum of $500 must accompany each bid. The right is reserved to reject any or all bids. For specifications and information apply to

G. A. ROULLIER, C. E.,
20 Main St.,
25-1t Flushing, N. Y.

NOTICE TO BRIDGE CONTRACTORS

Sealed proposals will be received by the undersigned, at the County Commissioners' office, Fairfield County Court House, at Bridgeport, Conn., until 10 a. m., of Thursday, June 29th, 1893, and then publicly opened, for furnishing all labor and material required in the construction of a pile foundation and masonry substructure, and the erection of an iron or steel superstructure (after design submitted by bidder) over the Housatonic River, between the counties of New Haven and Fairfield, on or near the site of the present bridge, known as Washington Bridge. The entire length of bridge will be six hundred and sixty (660) feet, and will consist of two fixed spans, each 230 feet in length, and a draw-span of 200 feet.

Only bids which contemplate the entire work, as named in the specifications, will be considered.

Plans, specifications, and any information desired, may be obtained at the office of Scofield & Starr, Room 2, City Hall, Bridgeport, Conn.

Each bid must be accompanied by a certified check, or its equivalent, for one thousand (1,000) dollars, payable to the undersigned, as Secretary of the Joint Board of County Commissioners, for the above named counties, as a guarantee that, in case the contract is awarded, the party or parties to whom the award is made, will, within five days after notification of award, execute said contract.

The Commissioners reserve the right to reject any or all bids.

By order of the joint Board of Commissioners for New Haven and Fairfield counties.

DANIEL M. ROWLAND,
Secretary.

Bridgeport, June 8, 1893. 24-2t

NOTICE TO SEWER CONTRACTORS.

ILION, N. Y., SEWERAGE.

Sealed proposals will be received by the Board of Sewer Commissioners of the Village of Ilion until July 6th, 1893, at noon, for the construction of a sewerage system for said village, consisting of furnishing and laying about 10.6 miles of vitrified sewer pipe with its branches, and the construction of about 100 manholes, 78 lampholes, 40 flush tanks and other appurtenances.

Bids will be received for the entire work. Plans may be seen at the office of the Commission, Ilion, N. Y., and specifications procured of Anthony Steber, Secretary.

The Board of Sewer Commissioners hereby reserve the right to reject any or all bids, or to accept any that in their judgment will be for the best interests of the village.

Bonds satisfactory to the Board in amount and sureties will be required of the one to whom the contract may be awarded.

Cash or a certified check, made payable to the Board of Sewer Commissioners of Ilion, N. Y., to the amount of $500 must accompany each bid as a guaranty that, in case the contract is awarded, the party or parties to whom the award is made will, within five days after notification of award, execute said contract.

Bids must be sealed and addressed to Anthony Steber, Secretary of Sewer Commissioners, Ilion, N. Y., and marked "Proposal for Sewer Construction."

JOHN HOEFLER, Pres't.
ANTHONY STEBER, Sec'y.
GEORGE F. WILCOX,
M. H. STERLING,
GEORGE WILFERT,
Board of Sewer Commissioners.

Ilion, N. Y., June 12, 1893. 25-2t

ROAD IMPROVEMENT.

NOTICE TO CONTRACTORS.

Sealed proposals are invited by the Commissioners appointed by the Board of Supervisors of Queens County for improving certain highways in the town of Jamaica, for grading, regulating and macadamizing the public highways in the town of Jamaica, New York, known as Locust avenue, Central avenue and Merrick road.

Specifications, blank proposals and full particulars regarding the work may be had at the office of Ezra W. Conklin, engineer, Jamaica, Long Island, and Frederick W. Dunton, 44 Broadway, New York City, until 4 o'clock p. m. on Friday, June 30, 1893, and from 7 until 8 o'clock p. m. of the same day, at the Supervisor's room, in the Town Hall, in the village of Jamaica, at which last named hour and place the bids will be publicly opened and read.

The right is reserved by the Commissioners to reject any or all bids.

FREDERICK W. DUNTON, Chairman.

25-1t

UTICA PIPE FOUNDRY CO.

CAST IRON PIPE AND SPECIALS FOR WATER AND GAS.

Also flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, etc. CHAS. MILLAR & SON, Selling Agents, Utica, N. Y. Manufacturers of Lead Pipe and Plumbers' Materials. Wholesale Eastern Agents Akron Vitrified Sewer Pipe.

JOHN W. HARRISON, Pres. and Treas. THOS. HOWARD, Vice-Pres.
F. B. NICHOLS, 2d Vice-Pres. E. H. QUEEN, Sec'y. P. MCARTHUR, Supt.

HOWARD-HARRISON IRON COMPANY,
MANUFACTURERS OF

CAST IRON PIPE

FOR WATER-WORKS, GAS WORKS, CULVERTS.
Pipe and Pump Connections. Flexible Joints. Heavy Loam Castings.
Works at BESSEMER, ALA. Offices at BESSEMER and ST. LOUIS.

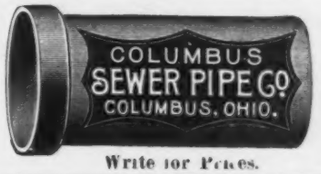
ARTHUR KIRK & SON, PITTSBURGH, PA.

POWDER, DYNAMITE, ROCK DRILLS,
AIR COMPRESSORS, ROCK BREAKERS,
Safety Fuse, Electric Batteries, Miners' Squibs.

FOR Best Results USE THE WARREN FILTER,
—MANUFACTURED BY—
CUMBERLAND MFG. CO., Boston, Mass.

THE STANDARD CONSTRUCTION CO.,
GENERAL CONTRACTORS.
SEWER AND MASONRY BUILDING, STREET PAVING, ETC.
Main Office, Lewis Block, Pittsburg, Pa.

Smoothness of motion, absolute safety and high speed are among the good qualities possessed by
OTIS ELEVATORS.
They are built by Otis Brothers & Co., 38 Park Row, New York.



Write for Prices.

Any company contemplating the expenditure of a large amount in the establishment of a manufacturing industry, requiring the use of a thoroughly equipped Machine shop, Boiler shop, Foundry and Smith shop plant, well located on competing trunk lines on railroads and in a good labor market, is invited to address Stimson Williams & Co., Bryant Building, 55 Liberty street, New York city.

TO SEWER CONTRACTORS.

Sealed proposals are invited for the complete construction of a sewer in the city of Morrison, Ill., including all the necessary materials therefor, as per plans, profiles and specifications now on file in the City Clerk's office of said city.

The sewer is known as the "Grape Street Sewer System," and consists of about

1,620 feet of 24-inch sewer pipe;
1,230 feet of 20-inch sewer pipe;
586 feet of 18-inch sewer pipe;
1,108 feet of 15-inch sewer pipe;
110 feet of 12-inch sewer pipe;
386 feet of 10-inch sewer pipe;
336 feet of 9-inch sewer pipe;
716 feet of 8-inch sewer pipe;

6,092;

16 manholes, 10 catch basins and 6 lampholes.

The contractor to give sufficient bonds for the completion of the work, and also to indemnify the city for any and all claims that may arise for labor and materials used in construction, if required.

Each bidder shall furnish samples of the pipe and brick to be used.

All bids to be filed in the office of the City Clerk on or before July 1, 1893.

The city reserving the right to reject any or all bids.

M. V. R. SMITH,
H. R. SAMPSON,
W. H. THACHER,
City Sewer Department.

Morrison, June 13, 1893. 25-2t

PROPOSALS FOR WATER-WORKS.

Sealed proposals will be received by the city of Dillon, Mont., until 8 p. m. of July 5th, 1893, for the material and labor incident to the construction of a system of water-works for the city, all proposals to be accompanied by a certified check to 10 per cent. of the amount of the bid. The city reserves the right to reject any or all bids. Plans and specifications can be seen at the office of the City Clerk in said city, or of Ray & Tingle, Engineers, Butte, Mont.

EDWIN NORRIS, City Clerk.

June 5, 1893. 24-2t

NOTICE OF SALE AT PUBLIC AUCTION.

On June 26, 1893, at 3 o'Clock P. M.
DIAMOND DRILLS FOR SALE.

The Aqueduct Commissioners of the City of New York, under the direction of Abram Hyatt, Auctioneer, will sell at public auction, at the office of their engineer, at Sing Sing, N. Y., the following property:

Two No. 7 diamond drill engines, complete, with mandrels, casings, drill rods, couplings, core barrels and other fittings, etc. Also 1 20-horse power porable boiler and 1 12-horse-power portable boiler with tools and fittings for same.

For particulars and terms of sale see "City Record," published at No. 2 City Hall, New York City, or inquire of C. S. Gowen, Division Engineer, or Abram Hyatt, Auctioneer, at Sing Sing, N. Y.

By order of the Aqueduct Commissioners.

J. C. DUANE, President.
J. C. LULLEY, Secretary.

24-2t

TO SEWER CONTRACTORS.

DAYTON, OHIO.

Office of the City Comptroller,
June 9, 1893.

Sealed proposals will be received at the office of the City Comptroller until 12 o'clock (noon) Monday, July 10th, 1893, for furnishing materials and constructing sewers and appurtenances in Sewer Districts Nos. 2, 3, 4 and 5, Dayton, O.

The work on which bids are solicited comprises about 4.016 lineal ft. of brick sewer, 40 ins. in diameter.

1,570 lineal ft. of brick sewer, 36 ins. in diameter.

750 lineal ft. of brick sewer, 30 ins. in diameter.

1,200 lineal ft. of brick sewer, 24 ins. in diameter.

300 lineal ft. of pipe sewer, 18 ins. in diameter.

1,500 lineal ft. of pipe sewer, 15 ins. in diameter.

4,400 lineal ft. of pipe sewer, 12 ins. in diameter.

6,520 lineal ft. of pipe sewer, 10 ins. in diameter.

49,055 lineal ft. of pipe sewer, 8 ins. in diameter.

100 lineal ft. of pipe sewer, 6 ins. in diameter.

3,000 lineal ft. of pipe sewer, 5 ins. in diameter.

15,700 lineal ft. of subsoil drains.
140 manholes.
79 flush tanks.
184 lampholes.
35 tons of iron pipe.
200,000 ft. (B. M.) of lumber, and other minor items.

A certified check on a National Bank for $2,500, payable to the order of the City Comptroller, will be required of each bidder as a guarantee that if any bid is accepted a contract will be entered into and the performance thereof properly secured.

The bond required of the successful bidder shall be in the sum of 50% of the contract price and must be given by residents of Montgomery County, Ohio, or said bond may be otherwise secured in a manner satisfactory to the Board of City Affairs, by whom said bond must be approved.

All bids must be made upon the printed forms to be obtained of the City Comptroller, and according to the directions therein contained.

The Board of City Affairs reserves the right to reject any or all bids, or waive defects in bids in the interest of the city.

Plans and specifications of the work are on file and may be seen at the office of the City Civil Engineer, and at the office of the Engineers of Sewers.

By direction of the Board of City Affairs.

J. H. WELLER,
President.

C. A. HERBIG,
City Comptroller.
CADY STALEY,
GEO. S. PIERSON,
Engineers.

Rooms 35 and 36 Chase Block,
Kalamazoo, Mich. 24-2t

PROPOSALS FOR CONSTRUCTION OF DAMS AND SHORE PROTECTIONS ON UPPER MISSISSIPPI RIVER, AND FOR FURNISHING ROCK AND BRUSH ON UNITED STATES BARGES.—U. S. Engineer Office, Rock Island, Ill., June 3, 1893.—Sealed proposals will be received at this office until two o'clock p. m. on the 6th day of July, 1893, and then publicly opened, for: 1. Furnishing thirty thousand (30,000) cubic yards of brush between St. Paul and Lake Pepin. 2. Furnishing ten thousand (10,000) cubic yards of rip-rap rock between St. Paul and Lake Pepin. 3. Construction of shore protections between Smith's Bar and Lake Pepin. 4. Furnishing twenty-five thousand (25,000) cubic yards of brush between Fountain City and Genoa, Wisconsin. 5. Furnishing ten thousand (10,000) cubic yards of rip-rap rock between Fountain City, Wis., and Brownsville, Minn. 6. Construction of dams and shore protections between Genoa and Prairie du Chien, Wis. 7. Construction of dams and shore protections between Dubuque and Clinton, Iowa. 8. Furnishing thirty thousand (30,000) cubic yards of brush between Keithsburg, Ill., and Montrose, Iowa. 9. Furnishing twenty-five thousand (25,000) cubic yards of rip-rap rock between Keithsburg, Ill., and Montrose, Iowa. 10. Furnishing twenty thousand (20,000) cubic yards of brush between Quincy Bridge and Clarksville, Mo. 11. Furnishing fifteen thousand (15,000) cubic yards rip-rap rock between Hannibal and Clarksville, Mo. 12. Construction of dams and shore protections between Clarksville, Mo., and Hamburg, Ill. 13. Construction of dams and shore protections between Hamburg, Ill., and Cap au Gris, Mo. 14. Construction of dams and shore protections between Cap au Gris, Mo., and mouth of the Illinois River. 15. Furnishing fifty thousand (50,000) cubic yards of brush within twenty-five miles of Plass Island. Specifications, blank forms, and all available information will be furnished on application to this office. 25-4t

PROPOSALS FOR STREET IMPROVEMENT.

Sealed proposals will be received by the Board of Councilmen of the City of Newport, Ky., at the council chamber, Thursday evening, June 29, 1893, until 8 o'clock, for the improvement by reconstruction and paving the roadway with brick or asphalt of Washington Ave., from Third St., to Eleventh St.; York St., from Third St. to Eighth St.; Isabella St., from Fourth St. to Ninth St.; Fourth St., from York St. to Brighton St.

Also for the improvement by reconstruction and macadamizing the roadway of Ninth St., from Mill St. to Norton St.

The work to be done in accordance with specifications on file in the office of the City Engineer, where copies of same and blank form of proposal and contract may be had.

The Board reserves the right to reject any or all bids.

B. MORTON,
City Engineer.

Newport, Ky., June 8, 1893. 24-2t

WATER WORKS—TOWN OF MEREDITH, N. H.

Sealed proposals will be received by the Water Commissioners of Meredith Village Fire District, in the town of Meredith, N. H., until 12 o'clock, noon, Thursday, June 30, 1893.

The work will consist of a reservoir of about 5,500,000 gallons capacity, covering about two and four-tenths (2 4-10) acres, and about five miles of pipe, varying in size from four (4) to ten (10) inches, requiring about 550 tons of cast iron pipe and special castings, together with about 30 gates and 33 hydrants.

The earthen dam will be about 300 feet long and about 26 feet high.

Proposals will be received for the above work, in whole or in part.

The contractor will state the time he will require to complete the work.

The Commissioners reserve the right to reject any or all proposals.

Specifications and plans can be seen upon application to the Water Commissioners at Meredith, N. H., or to Samuel M. Gray, Consulting Engineer, 20 Market Square, Providence, R. I. 24-2t

PROPOSAL FOR SEWER.

Oberlin, O., May 26, 1893.

Sealed proposals will be received by the Clerk of the village of Oberlin, Ohio, until 12 o'clock m., July 3, 1893, for furnishing and laying about 6,300 ft. 8-in. sewer pipe; 24,300 ft. 6 in. sewer pipe.

Also subsoil drains, specials, manholes, and other appurtenances, together with materials therefor.

Plans and specifications may be seen and blank proposals can be obtained at the office of the Engineer.

Bids for labor and material shall be separately stated, with the price thereof. Each proposal must contain the full name of the party or parties making the same and all parties interested therein, and must be accompanied by a certified check for $510 as a guarantee that a contract will be entered into.

No proposal will be entertained unless made on the blanks furnished by the Engineer and delivered to the Clerk previous to 12 o'clock m. on the day specified.

The Council reserves the right to reject any or all bids.

A. G. COMINGS, Mayor.
A. M. LOVELAND, Clerk.
24-2t W. B. GERRISH, Engineer.

TO SEWER CONTRACTORS.

DAYTON, OHIO.

Office of the City Comptroller,
June 9, 1893.

Sealed proposals will be received at the office of the City Comptroller until 12 o'clock (noon) Monday, July 10, 1893, for furnishing materials and constructing sewers, drains and appurtenances in sewer district number 8, Dayton, Ohio, and outlets thereto.

The work on which bids are solicited comprises about:

3,820 lineal ft. of sewer 12 ins. in diameter.
4,900 lineal ft. of sewer 10 ins. in diameter.
20,390 lineal ft. of sewer 8 ins. in diameter.
100 lineal ft. of sewer 6 ins. in diameter.
34,790 lineal ft. of subsoil drains.
63 manholes.
32 flush tanks.
36 tons of iron pipe. And other minor items.

A certified check on a National bank for $1,000, payable to the order of the city comptroller, will be required of each bidder as a guarantee that if any bid is accepted a contract will be entered into and the performance thereof properly secured.

The bond required of the successful bidder shall be in the sum of 50% of the contract price, and must be given by residents of Montgomery county, Ohio, or said bond may be otherwise secured in a manner satisfactory to the board of city affairs, by whom said bond must be approved.

All bids must be made upon the printed forms to be obtained of the city comptroller, and according to the directions therein contained.

The Board of City Affairs reserves the right to reject any or all bids, or waive defects in bids in the interest of the city.

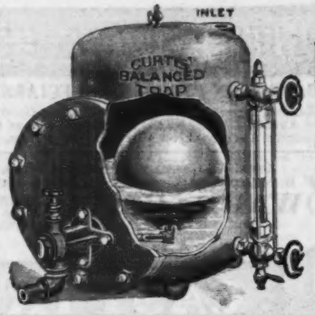
Plans and specifications of the work are on file, and may be seen at the office of the City Civil Engineer, and at the office of the Engineers of Sewers.

By direction of the Board of City Affairs.
J. H. WELLER,
President.

C. A. HERBIG,
City Comptroller.
CADY STALEY,
GEO. S. PIERSON,
Engineers.
Room 36, Chase Block,
Kalamazoo, Mich. 24-2t

OFFICE OF THE WASHINGTON AQUEduct, Washington, D. C., June 16th, 1893.—Sealed proposals will be received at this office until 2 o'clock, p. m., on Wednesday, the 28th inst., and then publicly opened, for furnishing and delivering near the Dalecarlia (receiving) Reservoir, of the Washington Aqueduct, about four miles from Washington, an Ingersoll-Sergeant Drilling Plant. A schedule of the articles wanted, specifications, and all necessary information will be furnished on application in person or by mail to GEORGE H. ELLIOT, Colonel of Engineers, U. S. A. 25-1t

PROPOSALS FOR STEAM TENDERS, quarter boats, etc.—U. S. Engineer Office, Room 430, Custom House, St. Louis, Mo., June 16, 1893.—Sealed proposals, in duplicate, for furnishing 3 steam tenders, 4 quarter boats, 1 office and survey boat, 12 barges, 11 pile drivers, 100 flats, 30 skiffs, and 10 yawls, will be received at this office until 12 m. July 17, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. CHAS. J. ALLEN, Major, Corps of Engineers. 25-3t



. . THE CURTIS . .
Balanced Steam Trap

Combines More Superior Features than any other Trap in the market.

One of them is that the SEAT and VALVE may be removed without breaking a joint, starting a gasket, or removing a pipe.

. . MANUFACTURED BY THE . .
D'ESTE & SEELEY CO.,
29-33 Haverhill St., Boston.
New York: 109 Liberty St. Chicago: 213 Lake St.

COMMONWEALTH OF MASSACHUSETTS.

METROPOLITAN SEWERAGE COMMISSIONERS.—NOTICE TO BUILDERS OF PUMPING ENGINES.

Sealed bids for the pumping plant for the pumping station at CHARLESTOWN will be received by the Board of Metropolitan Sewerage Commissioners at its office, 110 Boylston Street, Boston, Mass., until 12 o'clock m. of Saturday, July 1, 1893, and at that time will be publicly opened and read.

The Board will provide an engine-house, boiler-house, chimney and masonry foundations for the pumps, and will furnish a fresh water supply for the boilers up to the interior of the boiler-house. The contractor's bid must be for furnishing, setting up and completing, ready for use, two pumping engines (or sets of engines), two boilers, piping, and all necessary appliances and fittings, such as are to be found in pumping stations of the best class.

Each pumping engine must be capable of easily raising 35 cubic feet of sewage per second 11 feet vertically above the level of the sewage in its respective pump well. Each of the engines must also be capable of raising to greater lifts up to 30 feet, quantities of sewage inversely proportional to such lifts.

The contractors must provide at the station two steam boilers of such capacity that either of them can easily supply the necessary steam for the two engines when discharging together 70 cubic feet per second, with a lift of 11 feet.

The design of the pumping engines may be of any form which will fulfil the conditions named in the general specifications.

Each bid must be made on one of the blank forms furnished by the Board, and must be accompanied by a properly certified check for the sum of $1,000, the latter to be returned unless forfeited by abandonment of the proposal.

The Board reserves the right to reject any and all bids.

Plans, blank forms, general specifications and further information may be obtained at this office.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,
Board of Metropolitan Sewerage Commissioners of Massachusetts.
HOWARD A. CARSON,
19-8t Chief Engineer.

U. S. ENGINEER OFFICE, MOBILE, Ala., May 25, 1893.—To whom it may concern: Whereas, the navigation of Mobile River, Ala., at the city of Mobile is obstructed and endangered by a sunken drydock, lying near the foot of Elmira Street, Mobile, Ala., notice is hereby given to all persons interested in said drydock that, if within thirty (30) days from the date of the advertisement, they shall not have signified to me their intention, and taken preliminary steps to remove said drydock as soon as practicable, the same will be considered as abandoned and derelict, and it will be removed by the United States under authority of law. Sealed proposals, in duplicate, for the removal of said dry dock will be received at this office until 12 o'clock, noon, on June 26, 1893, and then opened. The United States reserves the right to reject any and all proposals, and to waive any informalities. Full information furnished upon application to this office. By authority of the Secretary of War. A. N. Damrell, Major of Engineers U. S. A. 22-4t

TREASURY DEPARTMENT, OFFICE Supervising Architect, Washington, D. C., June 16th, 1893.—Sealed proposals will be received at this office until 2 o'clock, p. m., on the 12th day of July, 1893, and opened immediately thereafter, for all the labor and materials required for the interior finish and plumbing of the United States Court House and Post-Office at Springfield, Missouri, in accordance with drawings and specification, copies of which may be had at this office or the office of the Superintendent, at Springfield, Missouri. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any and all bids and to waive any defect or informality in any bid, should it be deemed in the interest of the Government to do so. All bids received after the time stated will be returned to the bidders. Proposals must be inclosed in envelopes, sealed and marked, "Proposal for the Interior Finish and Plumbing of the United States Court House and Post Office, at Springfield, Missouri," and addressed to JEREMIAH O'ROURKE, Supervising Architect. 25-2t

U. S. ENGINEER OFFICE MONTGOMery, Ala., June 17th, 1893.—Sealed proposals for furnishing and delivering, at Wetumpka, Ala., about 110 cubic yards of granite dimension stone, will be received at this office until July 18th, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. PHILIP M. PRICE, Captain of Engineers, U. S. A. 25-1t

UNITED STATES ENGINEER OFFICE, Wilmington, Del., June 19th, 1893.—Sealed proposals for dredging and excavating for the construction of an inland waterway from Chincoteague Bay, Va., to Delaware Bay, Del., will be received at this office until 12 o'clock noon, July 18th, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. WM. P. SMITH, United States Agent. 25-4t

PROPOSALS FOR BRICK PAVING.

Sealed bids or proposals will be received by the Common Council of the city of Hornellsville, N. Y., at the Council Rooms in said city, until three o'clock p. m. on Wednesday, the fifth day of July, 1893, for paving with vitrified brick Main street, from the Canacadea Creek to the Canisteo River, in said city.

The approximate amount of work to be done is as follows: Six thousand (6,000) cubic yards of excavation, twenty-five thousand (25,000) square yards of pavement, nine thousand (9,000) lineal feet of curbing, eight thousand four hundred (8,400) lineal feet of 4-in. drain tile, one hundred and eighty (180) lineal feet circular curb corners.

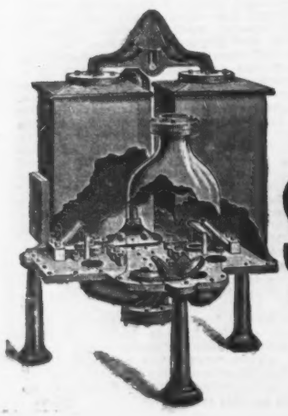
Plans may be examined and specifications and further information obtained at the office of F. A. Dunham, Engineer in Charge, 131 Main St., Hornellsville, N. Y.

A certified check for twenty-five hundred dollars ($2,500) must accompany each bid.

The Council reserves the right to reject any or all bids.

F. A. DUNHAM,
Engineer in Charge.
H. L. NASH, City Clerk. 25-2t

THE
GEO. E. NYE
IMPROVED
STEAM VACUUM PUMP



OFFICE AND FACTORY:
74-76 W. Washington Street, CHICAGO.